

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE**

VOITH PAPER GMBH & CO. KG,))	
Plaintiff,))	
v.))	C.A. No. 07-226-JJF
JOHNSONFOILS, INC.,))	
Defendant.))	
_____))	

**PLAINTIFF VOITH PAPER GMBH & CO. KG'S
ANSWERING BRIEF IN OPPOSITION TO
DEFENDANT JOHNSONFOILS, INC.'S MOTION
FOR LEAVE TO AMEND ITS COUNTERCLAIMS**

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Plaintiff Voith Paper GmbH & Co. KG (“Voith”) hereby opposes JohnsonFoils, Inc.’s (“JohnsonFoils”) Motion to Amend its Counterclaims (JohnsonFoils’ “Motion to Amend”) to include new declaratory judgment counterclaims of invalidity and noninfringement against Voith’s United States Patents Nos. 5,389,206 (“the ’206 patent”), 5,853,544 (“the ’544 patent”), and 5,500,091 (“the ’091 patent”) (collectively, the “Unasserted Patents”). A tactical move almost surely calculated to delay these proceedings and impose undue burdens on Voith, JohnsonFoils’ proposed amendment, if allowed, would more than double the number of patents at issue in this case to include three patents that Voith never asserted, or even threatened to assert, against JohnsonFoils. JohnsonFoils does not contend that Voith threatened enforcement of the Unasserted Patents, but grounds its new counterclaims on its assertion that the Unasserted Patents share “subject matter” with the Patents-in-Suit. This vague allegation of shared subject matter does nothing to rebut the presumption that the claims of the Unasserted Patents—even though generally directed to paper forming—have scope different from any claim asserted, or threatened to be asserted, against JohnsonFoils. Among other reasons, JohnsonFoils’ proposed amendment should thus be denied as futile for failing to recite sufficient grounds for this Court’s exercise of declaratory judgment jurisdiction.

Moreover, without exception, each purported ground for relating the Unasserted Patents to this case was known to JohnsonFoils prior to JohnsonFoils’ filing of its first responsive pleading on August 13, 2007. Assuming the truth of JohnsonFoils’ claim that the Unasserted Patents share subject matter with the Patents-in-Suit sufficient to support declaratory judgment jurisdiction, JohnsonFoils offers no excuse for its delay from the time it was *required*, pursuant to Fed. R. Civ. P. 13, to assert any known counterclaims in August, 2007, to the December 21 date of its Motion to Amend. JohnsonFoils’ dilatory amendment prejudices Voith because

JohnsonFoils' unexplained delay practically ensures that claims relating to the three Unasserted Patents will not be added prior to the parties' Markman Brief submission deadline of January 16, 2008. In addition, JohnsonFoils' new counterclaims will not be added prior to the last day for filing a timely discovery request under the Scheduling Order. JohnsonFoils' delay further prejudices Voith by requiring Voith to repeat a costly search of its files for information and documents relevant to JohnsonFoils' new claims.

For the foregoing reasons, and as explained more fully below, JohnsonFoils Motion to Amend should be denied.

NATURE AND STAGE OF PROCEEDINGS

This is a patent infringement action. The Complaint, asserting United States Patent Nos. 5,718,805 ("the '805 patent") and 5,972,168 ("the '168 patent") (collectively, "the Patents-in-Suit") against JohnsonFoils, Inc., was filed by Voith on April 27, 2007, against the Defendant JohnsonFoils. *See* Complaint, D.I. 1. Voith's first served discovery requests on JohnsonFoils on July 26, 2007. After requesting and obtaining several unopposed extensions of time, JohnsonFoils filed its answer, affirmative defenses, and counterclaims, on August 13, 2007. *See* "Defendant, JohnsonFoils, Inc.'s Answer, Affirmative Defenses, and Counterclaims to Plaintiff, Voith Paper GmbH & Co. KG's Complaint," (JohnsonFoils's "Answer, Defenses, and CounterClaims") D.I. 19. Voith replied to the Counterclaims on September 5, 2007. *See* "Voith's Answer to Defendant's CounterClaims," D.I. 31.

On August 1, 2007, a scheduling conference pursuant to Fed. R. Civ. P. 16(b) was held. A Scheduling Order was entered on August 3, 2007, ordering that the "[e]xchange and completion of contention interrogatories, identification of fact witnesses and document

production shall be commenced so as to be completed by February 15, 2008.” Rule 16(b) Scheduling Order, “Scheduling Order,” D.I. 17.

On August 16, 2007, JohnsonFoils served seven (7) deposition notices before written discovery had even begun. JohnsonFoils filed a “Motion for Summary Judgment That U.S. Patents 5,718,805 and 5,972,168 are Invalid,” on August 22, 2007. D.I. 25. JohnsonFoils withdrew that motion on August 24, 2007. *See* JohnsonFoils’s Notice of Motion to Withdraw its Motion for Summary Judgment, dated August 24, 2007, D.I. 26.

JohnsonFoils filed its “Defendant’s Motion to Stay the Proceedings Pending Reexamination of the Patents in Suit or in the Alternative For Leave to File a Motion for Summary Judgment Prior to August 20, 2008 That U.S. Patents 5,718,805 and 5, 972,168 are Invalid” on August 28, 2007. (JohnsonFoils’ “Motion for Stay”) D.I. 28. Voith filed its response on September 17, 2007. D.I. 33. JohnsonFoils’ Motion is currently pending and no hearing date has been set.

Both parties have served discovery requests and their respective objections and responses to discovery requests.

Voith filed its “Motion to Compel Defendant JohnsonFoils, Inc. to Provide Information Requested in Voith’s First and Second Sets of Interrogatories and to Produce Documents Responsive to Voith’s First and Second Requests for Documents” on November 9, 2007. D.I. 43 (“Voith’s Motion to Compel”). JohnsonFoils’ “Opposition to [Voith’s Motion to Compel]” was filed on November 28, 2007. D.I. 46. Voith filed its “Reply to JohnsonFoils’ Opposition to Voith’s Motion to Compel” on December 3, 2007, D.I. 48. The Court issued an Oral Order on December 6, 2007, cancelling the scheduled December 7 Motion Day hearing and stating that the Court would rule based on the parties’ written submission.

JohnsonFoils filed its Motion to Compel on December 17, 2007. Voith filed its Motion for a Protective Order on December 18, 2007. Briefing on both Motions is expected to be complete by Wednesday, January 16, 2008.

Briefs for a Markman Hearing scheduled for January 30, 2008, are due on January 16, 2008.

STATEMENT OF FACTS

A. The Parties' Allegations Are Limited to the Patents-in-Suit

Voith's Complaint alleges that JohnsonFoils has infringed Voith's '168 patent and '805 patent. *See* Complaint, D.I. 1. Voith's complaint contains no reference to other patents, such as the '544 patent, the '091 patent, and the '206 patent. *Id.*

JohnsonFoils filed its Answer and Counterclaims on August 13, 2007. ("Answer and Counterclaims") D.I. 19. JohnsonFoils' Counterclaims make no reference to any Voith patent claim other than the claims of the '805 patent and the '168 patent. *Id.* JohnsonFoils' Answer and Counterclaims further alleges no facts relating to any threat, perceived or actual, to JohnsonFoils based on any Voith patent claim other than the claims of Voith's '168 and '805 patents. *Id.*

B. No pending dispute relating to the claims of the Unasserted Patents

1. Voith has not asserted the Unasserted Patents against JohnsonFoils

Voith has never asserted, or threatened to assert, any claim of the Unasserted Patents against JohnsonFoils. *See* Complaint, D.I. 1. JohnsonFoils has not alleged that Voith ever threatened to enforce the Unasserted Patents against JohnsonFoils. *See* Motion to Amend.

2. The Unasserted Patents contain claims different from the claims of the Patents-in-Suit.

Although related to the Patents-in-Suit, the Unasserted Patents contain claims that are different from the claims of the Patents-in-Suit. *See* '168 patent, Cols. 7-10 (claims), Exh. 1; '805 patent, Cols. 8-12 (claims), Exh. 2; '544 patent, Cols. 8-10 (claims), Exh. 3; '091 patent, (claims), Exh. 4; '206 patent, Cols. 8-10 (claims), Exh. 5. Apart from a generalized claim that the Unasserted Patents "concern the same subject matter," Motion to Amend at pp. 3-4, and 6, JohnsonFoils' Motion to Amend states no facts to support its allegation that its products are threatened by the claims of the Unasserted Patents.

3. Voith's discovery-limited definition of "Accused Product" does not constitute a threat to assert any claim of the Unasserted Patents.

On July 26, Voith served its First Set of Requests for Documents and its First Set of Interrogatories (collectively, Voith's "First Discovery Requests"), each including definitions of terms that were expressly limited to the context of the discovery requests. *See* First Set of Interrogatories (Definitions), Exh. 6; First Set of Document Requests (Definitions), Exh. 7. Voith's First Discovery Requests include a definition of the term "Accused Product" which states "as used herein, Accused Product means a twin wire former that has resiliently mounted blades." *See* First Set of Interrogatories, at p. 5; First Set of Document Requests (incorporating the definitions of the First Set of Interrogatories) (emphasis supplied). The definitions of terms in Voith's discovery requests are expressly limited to the purposes of discovery. *Id.*

JohnsonFoils subsequently objected to Voith's discovery-limited definition of "Accused Product":

JohnsonFoils objects to Voith's Interrogatories as its definition of the term "Accused Products" is vague and unclear, and to the extent that any such definition refers to products that are irrelevant to the subject matter of the present suit.

Defendant JohnsonFoils' Responses to Voith's First Set of Interrogatories, at p. 2, ("JohnsonFoils' Objections").

C. JohnsonFoils' Unexplained Delay in Requesting Amendment.

1. JohnsonFoils was aware that the Unasserted Patents are related to the Patents-in-Suit prior to filing its original counterclaims.

JohnsonFoils was at least aware of the Unasserted Patents and their relationship to the Patents-in-Suit prior to filing its original counterclaims on August 13, 2007. *See* '168 patent, Col. 1:4-14 (expressly citing the '206 patent and the '091 patent); '805 patent, Col. 1:4-11; '544 patent, Col. 1:4-13 (expressly identifying the parent '805 patent, '206 patent, and '091 patent).

JohnsonFoils was also aware of Voith's discovery-limited definition of "Accused Product" well before filing its original counterclaims on August 13, 2007. *See* Voith's First Set of Interrogatories, served July 26, 2007, at p. 2.

2. JohnsonFoils repeatedly demonstrated its awareness of the Unasserted Patents throughout the subsequent months, but did nothing to raise the issue in this case until the last day to file this Motion.

JohnsonFoils expressly discussed the relationship between Unasserted Patents and the Patents-in-Suit in its Memorandum of Law in Support of Defendant's Motion for Summary Judgment That [the Patents-in-Suit] are Invalid ("Summary Judgment Motion"), filed August 22, 2007. *See* Summary Judgment Motion, at p. 29, D.I. 25.

JohnsonFoils filed requests for reexamination of the Unasserted Patents with the United States Patent and Trademark Office on November 16, 2007.

3. **JohnsonFoils asserted the declaratory judgment claims at issue in its Motion to Amend in a separate action but continued to avoid raising those claims in this action.**

JohnsonFoils filed a Declaratory Judgment Action on November 27, 2007. JohnsonFoils' Complaint, Exh. G to JohnsonFoils' Motion to Amend (JohnsonFoils' "DJ Action") seeking a declaration that the Unasserted Patents were invalid and not infringed. The DJ Action makes no mention of any intent to raise those claims in this action. *Id.*

4. **Finally, on the last possible date permitted by the Scheduling Order for amending pleadings, JohnsonFoils requested that claims identical to the DJ claims raised in its DJ Action be added to this case.**

The allegations in JohnsonFoils' DJ Action—identical to the claims in JohnsonFoils' Motion to Amend—were raised in this case for the first time on December 21, 2007, the last possible day for requesting amendments. *See* Scheduling Order, ¶ 5, D.I. 17. The Scheduling Order states that "All motions to amend the pleadings shall be filed on or before December 21, 2007." *Id.*

D. Undue Prejudice to Voith Resulting from JohnsonFoils' Unexplained Delay

1. **If allowed, JohnsonFoils' amendments would leave no time for further discovery relating to JohnsonFoils' new claims.**

The last possible day for timely serving document requests or interrogatories is January 16, 2008, well before the likely completion of the briefing on JohnsonFoils' Motion to Amend, and well ahead of any decision. *See* Scheduling Order, D.I. 17 (discovery to be conducted so as to be completed by February 15, 2008).

2. **If allowed, JohnsonFoils' amendments would leave no time for Voith to address the construction of the claims of the Unasserted Patents in its Markman Brief.**

Briefs relating to the Markman claim construction Hearing are due to be filed on Wednesday, January 16, 2008, well before the likely completion of briefing on JohnsonFoils' Motion to Amend. Scheduling Order, ¶ 5, D.I. 17.

SUMMARY OF ARGUMENT

1. JohnsonFoils' Motion to Amend to add new counterclaims of noninfringement and invalidity relating to the '091, '544, and '206 patents ("Unasserted Patents") should be denied as futile because JohnsonFoils has failed to allege facts sufficient to support declaratory judgment jurisdiction. Voith has never asserted the Unasserted Patents against JohnsonFoils, or even threatened to do so. Therefore, there is no justiciable dispute between Voith and JohnsonFoils relating to the Unasserted Patents. JohnsonFoils' assertion that the Unasserted Patents are directed to the "same subject matter" as the Patents-in-Suit is insufficient because it fails to rebut the legal presumption that each claim of the Unasserted Patents has different scope from any claim of the Patents-in-Suit. As an additional ground of futility, this Court should decline to accept jurisdiction over claims directed to the Unasserted Patents on discretionary grounds given JohnsonFoils' unexplained failure to assert claims relating to the Unasserted Patents in its first responsive pleading and its subsequent unexplained delay of over four months.

2. JohnsonFoils' Motion to Amend should also be denied because JohnsonFoils' unexplained delay in filing its amendment is prejudicial to Voith. JohnsonFoils was aware of the Unasserted Patents prior to filing its Answer and Counterclaims on August 13, 2007. JohnsonFoils' sole basis for supporting the existence of a controversy with respect to the Unasserted Patents—that Voith defined, for the purposes of its discovery requests, the term

Accused Product, generally to include any paper former with resiliently mounted blades—was also known to JohnsonFoils prior to filing its Answer and Counterclaims. JohnsonFoils also filed a separate action asserting the identical declaratory judgment counterclaims now sought to be added by amendment on November 27, 2007, but delayed filing its Motion to Amend until nearly a month later on December 21, 2007—the last possible day.

3. JohnsonFoils' unexplained four month delay in requesting the addition of declaratory judgment counterclaims relating to the Unasserted Patents is prejudicial to Voith because 1) if the Unasserted Patents are added, there will be no time under the current Scheduling Order to serve timely discovery requests relating to the Unasserted Patents, 2) if the Unasserted Patents are added, the time for submitting a timely Markman Brief which addresses the claims of the Unasserted Patents will have passed, and 3) if the Unasserted Patents are added, Voith will be forced to incur the additional burden of duplicating its search through Voith's files to include the subject matter of the Unasserted Patents prior to the fast-approaching close of discovery on February 15, 2008. Because of JohnsonFoils' unexplained four month delay, the additional burdens imposed on Voith by permitting the Proposed Amendment are undue.

4. JohnsonFoils' Motion to Amend should also be denied because—as evidenced by JohnsonFoils' otherwise unexplained delay and the fact that JohnsonFoils has never been threatened with enforcement of the Unasserted Patents—the amendment has been proposed for the improper purpose of delaying these proceedings and needlessly increasing the cost of litigation.

5. JohnsonFoils' Motion to Amend should be denied notwithstanding the possibility that JohnsonFoils may at some time in the future seek to consolidate its separately filed action relating to the Unasserted Patents with this action. Because JohnsonFoils has failed to adduce

any ground sufficient to support declaratory judgment jurisdiction for claims relating to the Unasserted Patents, the possibility that the separately filed claims will survive to support a Motion for Consolidation is speculative. In addition, the likely disruption of this action resulting from JohnsonFoils' undue delay in raising the proposed new counterclaims and the likely prejudice to Voith weighs against consolidation.

ARGUMENT

JohnsonFoils' Motion to Amend to add declaratory judgment counterclaims of noninfringement and invalidity relating to the Unasserted Patents should be denied because Voith has never asserted, or threatened to assert, the Unasserted Patents against JohnsonFoils. Consequently, there is no basis for JohnsonFoils' invocation of declaratory judgment jurisdiction and adding these counterclaims would be futile. *See MedImmune, Inc. v. Genentech, Inc.*, 127 S.Ct. 764, 771 (2007) (alleged dispute must be of sufficient immediacy and reality to warrant declaratory relief); *Teva Pharms. USA, Inc. v. Novartis Pharms. Corp.*, 482 F.3d 1330, 1337-38 (Fed. Cir. 2007) (declaratory plaintiff must demonstrate standing, including a definite and concrete injury-in-fact, and that the issue for which declaratory relief is sought must be ripe for judicial determination); *Sandisk Corp. v. STMicroelectronics, Inc.*, 480 F.3d 1372, 1378 (Fed. Cir. 2007).

Although requests to amend the pleadings pursuant to Fed. R. Civ. P. 15(a) ("Rule 15") are liberally granted, leave to amend is properly denied where the proposed claims would not survive a motion to dismiss. *See Foman v. Davis*, 371 U.S. 178, 182 (1962) (futility of amendment is grounds for denying leave to amend pursuant to Rule 15(a)); *In re Burlington Coat Factory Sec. Litig.*, 114 F.3d 1410, 1434 (3d Cir. 1997) (same); *Massarsky v. General*

Motors Corp., 706 F.2d 111, 125 (3d Cir.1983) (court may properly deny leave to amend if the claims as amended would not survive a motion to dismiss).¹

Moreover, JohnsonFoils knew of every fact relating to the Unasserted Patents it now cites to support its proposed declaratory judgment counterclaims of noninfringement and invalidity *prior* to filing its original counterclaims over four months ago. JohnsonFoils' unexplained delay prejudices Voith since, as explained below, the proposed amendment would likely delay this action and increase Voith's litigation costs. *See DRR L.L.C. v. Sears, Roebuck & Co.*, 171 F.R.D. 162, 167 (D. Del. 1997) (a movant who offers no adequate explanation for its delay will normally be denied leave to amend). Because JohnsonFoils' undue delay prejudices Voith, JohnsonFoils' request to add its declaratory judgment counterclaims relating to the Unasserted Patents is properly denied. *See Foman*, 371 U.S. at 182 (amendment pursuant to Rule 15(a) is properly denied where the amendment is unduly delayed to the prejudice of the nonmoving party); *Barkauskie v. Indian River School Dist.*, 951 F. Supp. 519, 527 (D. Del. 1996) (For the purpose of Federal Rule of Civil Procedure 15(a), prejudice "concerns only the prejudice resulting from the fact of adding new claims at a late date.") General allegations that claims relating to new patents or concern similar subject matter are insufficient to negate the prejudice resulting from an unduly delayed Motion to Amend. *See Miller Prods Co., Inc. v. Veltek Assoc. Inc.*, 218 F.R.D. 425, 426-27 (D. Del. 2003) (denying leave to amend to include claims to an additional patent where delay was unexplained despite purported overlap in subject matter).

¹ Since Voith has served its Answer to JohnsonFoils' originally filed counterclaims, Rule 15(a) requires JohnsonFoils to obtain leave of the court to amend its counterclaims.

I. JOHNSONFOILS' MOTION TO AMEND SHOULD BE DENIED AS FUTILE BECAUSE THE PROPOSED NEW COUNTERCLAIMS RELATE TO UNASSERTED PATENTS FOR WHICH THERE IS NO DECLARATORY JUDGMENT JURISDICTION

A. The Proposed New Counterclaims Relate to Patents That Voith Has Never Asserted, or Threatened to Assert, Against JohnsonFoils

1. The claims of the Patents-in-Suit have different scope from the claims of the Unasserted Patents subject to JohnsonFoils' new counterclaims.

JohnsonFoils' Motion to Amend should be denied as futile because it improperly seeks to add, after an unexplained delay of over four months, declaratory judgment counterclaims relating to patents that have never been asserted, or threatened to be asserted, against JohnsonFoils.

JohnsonFoils' attempt to gloss over the differences between the unasserted '091, '206, and '544 patents (the "Unasserted Patents"), does nothing to rebut the presumption that the claims of the Unasserted Patents have different scope from the claims of the Patents-in-Suit. *See Forest Labs, Inc. v. Abbott Labs.*, 239 F.3d 1305, 1310 (Fed. Cir. 2001) ("Where claims use different terms, those differences are presumed to reflect a difference in the scope of the claims.") (citing *Tandon Corp. v. United States Int'l Trade Comm'n*, 831 F.2d 1017, 1023 (Fed. Cir. 1987)). Because of the difference in scope between the claims of the Patents-in-Suit and the claims of the Unasserted Patent, Voith's assertion of the Patents-in-Suit does nothing to justify the exercise of declaratory judgment jurisdiction over JohnsonFoils' new counterclaims.

2. Voith's use of a broad definition of "Accused Product" expressly limited to the context of Voith's discovery requests does not amount to an allegation that the Unasserted Patents are infringed.

JohnsonFoils does not even allege that Voith has ever threatened to enforce the Unasserted Patents against JohnsonFoils, instead erroneously resting its claim to the existence of a dispute as to the Unasserted Patents on a definition taken out of context from Voith's First Set of Interrogatories to JohnsonFoils. In Voith's First Set of Interrogatories, Voith stated that the

term “Accused Product” as used in Voith’s discovery requests includes paper formers modified by JohnsonFoils to include one or more resiliently supported blades. *See* Voith’s First Set of Interrogatories, at p. 5. Specifically, Voith provided the following definition:

The terms “Accused Product” and “Accused Products” as used herein means each and every paper forming machine which Defendant has modified, or contracted to modify, to utilize one or more resiliently supported blades.

Id. (emphasis supplied). This definition, expressly limited to Voith’s discovery requests with the qualifier “as used herein” plainly has no proper application outside Voith’s requests for discovery. In accordance with the Federal Rules of Civil Procedure, Voith chose to define its discovery requests broadly in order to obtain both relevant evidence and information intended to lead to the discovery of relevant evidence. Given the express limitation of the definition to discovery requests, this definition cannot be fairly read as an infringement allegation of any sort.

Furthermore, having expressly discussed the numerous other claim limitations of the Patents-in-Suit—besides resiliently supported blades—in its various pleadings, JohnsonFoils cannot have reasonably believed that Voith’s discovery-limited definition of Accused Product amounted to such a broad infringement allegation. JohnsonFoils’ apparent claim to the contrary is disingenuous.

3. JohnsonFoils’ Further Assertion that Voith’s First Set of Interrogatories Directly Alleged Infringement of the Unasserted Patents is False.

JohnsonFoils’ further claim that Voith’s definition of Accused Product relates to the infringement of the Unasserted Patents results from a further blatant mischaracterization of Voith’s First Set of Interrogatories. *See* Motion to Amend at 6. Specifically, JohnsonFoils states that “Voith asserted that any JohnsonFoils’ twin wire former products that utilize resiliently mounted blades . . . infringe Voith’s Twin Wire Former Patents.” *Id.* But the term “Voith’s

Twin Wire Former Patents” is defined by JohnsonFoils to include both the Patents-in-Suit and the Unasserted Patents. *Id.* at p. 3. Voith’s First Set of Interrogatories contains no reference to the term “Voith’s Twin Wire Former Patents” and nowhere mentions the Unasserted Patents. JohnsonFoils’ apparent claim to the contrary is plainly incorrect.

4. JohnsonFoils’ sole remaining basis for declaratory judgment jurisdiction, that the Unasserted Patents are related to the Patents-in-Suit, is insufficient.

Because Voith never asserted, or threatened to assert, the Unasserted Patents against JohnsonFoils, JohnsonFoils sole claim for declaratory judgment jurisdiction is the unremarkable fact that the Unasserted Patents share a common parent application with the Patents-in-Suit. Because of this shared parentage, both the Patents-in-Suit and the Unasserted Patents have a common specification. However, the measure of a patent dispute—the most important consideration for assessing the existence, or nonexistence, of declaratory judgment jurisdiction—is the scope of a patent’s claims, not its specification.

B. JohnsonFoils’ Argument That Its Proposed Counterclaims Are Not Futile Blatantly Mischaracterizes its Counterclaims.

Lacking any evidence of a dispute relating to the Unasserted Patents sufficient to support declaratory judgment jurisdiction, JohnsonFoils defends its proposed counterclaims by mischaracterizing the proposed counterclaims as “essentially identical to JohnsonFoils’ existing counterclaims.” Motion to Amend, at p. 7. Yet, it is beyond dispute that the proposed new counterclaims relate to different patent claims—the claims of the Unasserted Patents—than the claims of the Patents-in-Suit. In view of this essential difference, JohnsonFoils’ assertion that its proposed new noninfringement and invalidity counterclaims are “essentially identical” to its original counterclaims is inexplicable.

The importance of the difference between JohnsonFoils' original and JohnsonFoils' newly proposed counterclaims is underscored by JohnsonFoils' further outlandish contention that its *new counterclaims* cannot be deemed futile because Voith's didn't move to dismiss JohnsonFoils' *original counterclaims*. Motion to Amend, at p. 7. Plainly, Voith did not challenge the existence of declaratory judgment jurisdiction for JohnsonFoils' original counterclaims because those counterclaims related to patents which Voith has actually asserted against JohnsonFoils: The Patents-in-Suit. Voith's reason for not challenging the existence of declaratory judgment jurisdiction for JohnsonFoils' original counterclaims has no applicability to the Unasserted Patents challenged by JohnsonFoils' newly proposed counterclaims because Voith has never asserted, or threatened to assert, the Unasserted Patents against JohnsonFoils. JohnsonFoils' assertion to the contrary is plainly incorrect.

II. JOHNSONFOILS' MOTION TO AMEND SHOULD BE DENIED BECAUSE JOHNSONFOILS' UNEXPLAINED DELAY PREJUDICES VOITH

A. JohnsonFoils knew of every ground now relied upon to support its proposed counterclaims prior to filing its original Answer and Counterclaim on August 13, 2007

Apart from the futility of JohnsonFoils' proposed new counterclaims resulting from the absence of any factual basis for a dispute relating to the Unasserted Patents, JohnsonFoils' unexplained delay and the resulting prejudice to Voith provides an independent ground for denying JohnsonFoils' Motion to Amend. Significantly, no asserted ground for JohnsonFoils' new counterclaims was unknown to JohnsonFoils prior to the filing of JohnsonFoils' original Answer and Counterclaims on August 13, 2007.

1. Voith served its discovery requests containing the discovery-limited definition of Accused Product at issue on July 26, 2007, prior to JohnsonFoils' Answer and Counterclaims.

Although, as explained above, Voith's broad discovery-limited definition of Accused Product is not an infringement allegation, JohnsonFoils knew of this definition well before it filed its original Answer and Counterclaims on August 13, 2007. In fact, Voith's First Set of Interrogatories, containing the discovery-limited definition of "Accused Product" at issue, was served on July 26, 2007. Notwithstanding this fact, JohnsonFoils surprisingly relies on the following assertion to "reasonably explain" JohnsonFoils' delay:

After JohnsonFoils filed its [Answer and Counterclaims] Voith asserted that any JohnsonFoils twin wire former products that utilize resiliently mounted blades is an "Accused Product," infringe (*sic*) Voith's Twin Wire Former Patents.

Motion to Amend, at pp. 5-6 (citing Voith's First Set of Interrogatories). First, in light of the fact that Voith provided the discovery-limited definition of Accused Product to JohnsonFoils well **before** JohnsonFoils filed its Answer and Counterclaims, JohnsonFoils' "reasonable explanation" is false, and explains nothing. Second, JohnsonFoils' Motion to Amend defines "Voith's Twin Wire Former Patents" to include both the Patents-in-Suit and the Unasserted Patents. *See* Motion to Amend at p. 3. JohnsonFoils' definition of "Voith's Twin Wire Former Patents"—or any reference to the Unasserted Patents for that matter—occurs nowhere in the cited Voith's First Set of Interrogatories. Consequently, JohnsonFoils' claim that Voith asserted anything about the Unasserted Patents in Voith's First Set of Interrogatories is also incorrect, and does nothing to explain JohnsonFoils' delay.

2. JohnsonFoils was also aware of the Unasserted Patents prior to filing its original Answer and Counterclaims.

Although, as explained above, JohnsonFoils is incorrect to assume that patents sharing a common parent patent application have claims with identical scope, the family relationship

between the Unasserted Patents and the Patents-in-Suit was also known to JohnsonFoils prior to filing its original Answer and Counterclaims. Both the '168 patent and the '805 patent expressly state that they result from continuations of the parent '206 patent and '091 patents. *See* '805 Patent, Col. 1:4-11; '168 Patent, Col. 1:4-14. Thus, at least two of the Unasserted Patents, the '206 patent and the '091 patent were known to JohnsonFoils prior to the filing date of its original counterclaims. Moreover, taking JohnsonFoils at its word that Voith's definition of Accused Product, served on July 26, 2007, implicated all family members of the parent '206 patent, JohnsonFoils could have easily identified the '544 patent, which expressly recites that it is a continuation of the '805 patent, and is similarly descended from the '091 patent and the '206 patent. *See* '544 patent, Col. 1:4-12. To the extent that JohnsonFoils considers these Unasserted Patents to give rise to a declaratory judgment claim due to any shared "subject matter," JohnsonFoils should have asserted those counterclaims with its original counterclaims on August 13, 2007. *See* Fed. R. Civ. P. 13(a) (directing the defendant assert in its responsive pleading any counterclaim arising out of the same transaction or occurrence that is within the subject matter of the plaintiff's claim).

B. Subsequent to Filing Its Original CounterClaims, JohnsonFoils Continued to Delay Moving to Amend Its CounterClaims Without Any Justification.

Subsequent to filing its original counterclaims, JohnsonFoils demonstrated its continuing awareness of the Unasserted Patents, but made no move to amend its counterclaims. For example, JohnsonFoils' Memorandum of Law in Support of Defendant's Motion for Summary Judgment that [the Patents-in-Suit] are Invalid, ("JohnsonFoils' Summary Judgment Motion"), filed on August 22, 2007, just nine days after filing its original counterclaims, expressly discusses the '206 patent and the '091 patent. *See* JohnsonFoils' Motion for Summary Judgment, pp. 11-14, D.I. 25.

In addition, Voith served its Second Set of Interrogatories containing the very same definition of Accused Product cited by JohnsonFoils as the basis for its proposed new declaratory judgment counterclaims, on August 16, 2007. *See* Voith's Second Set of Interrogatories, at p. 6. Yet, even then, JohnsonFoils made no attempt to amend its counterclaims.

Months later, on November 16, 2007, JohnsonFoils filed reexamination requests for each of the Unasserted Patents, but still made no attempt to amend its Counterclaims in this action. *See* JohnsonFoils' Complaint, ¶ 15, Exh. G to JohnsonFoils' Motion to Amend. Finally, JohnsonFoils filed a separate declaratory judgment action on November 27, 2007, asserting the *identical* claims now proposed to be added to this action. *Id.* Yet, not until December 21, 2007, the last day permitted by the Scheduling Order, and several weeks after filing its DJ Action, did JohnsonFoils finally request leave to amend its original counterclaims to include new declaratory judgment counterclaims relating to the Unasserted Patents.²

C. JohnsonFoils' Motion to Amend Should be Denied Because JohnsonFoils' Delay is Undue and is Likely the Result of Dilatory Motives.

JohnsonFoils' delay in seeking amendment is undue because, as explained in detail above, every fact cited by JohnsonFoils to support the existence of declaratory judgment jurisdiction for the newly proposed counterclaims was known to JohnsonFoils prior to the time it filed its original Counterclaims on August 13, 2007. Taking JohnsonFoils at its word that the cited facts were a sufficient basis for asserting the newly proposed counterclaims, the delay from

² Aware that it has no valid explanation for delaying its request to amend its original counterclaims, JohnsonFoils incredibly suggests that Voith's insistence that service of the complaint in JohnsonFoils' separate action be made in accordance with the Hague Convention excuses JohnsonFoils' delay. Motion to Amend, p. 6-7. JohnsonFoils fails to explain why it filed a separate action instead of moving to amend its counterclaims in the first instance. The likely reason is that JohnsonFoils was aware that it had no excuse for its delay, and hoped to avoid the issue by filing a separate action and presenting this Court with a fait accompli in the form of a Motion for Consolidation.

August 13, 2007, to December 21, 2007, is completely unexplained. Moreover, given the unexplained delay of over four months, JohnsonFoils is not excused by the mere fact that its December 21 requested amendment technically falls within the December 21 deadline set by the Court's Scheduling Order. The relevant inquiry for determining whether a delay is undue is "whether the moving party knew or should have known the facts and theories raised by the amendment in its original pleading." *See Jackson v. Bank of Hawaii*, 902 F.2d 1385, 1388 (9th Cir. 1990) (motions to amend made within the time allowed by a scheduling order are nonetheless unduly delayed if the movant knew the facts supporting the amendment at the time of the movant's original pleading); *Sierra Club v. Union Oil Co. of California*, 813 F.2d 1480, 1492-93 (9th Cir. 1987), vacated on other grounds by *Union Oil Co. of California v. Sierra Club*, 485 U.S. 931 (1988). As explained in detail above, JohnsonFoils knew all the facts cited to support its Motion to Amend well before filing its original counterclaims on August 13, 2007.³

JohnsonFoils' failure to provide any explanation for its delay strongly suggests that its Amendment is offered for a dilatory motive. JohnsonFoils has made it plain that it would like to delay this action pending the outcome of the pending reexamination of the Patents-in-Suit. *See* Motion to Stay, D.I 27. By waiting until the last possible day before technically filing its Motion to Amend within the time set by the Scheduling Order, JohnsonFoils has ensured that, if granted, its amendment will likely delay the scheduled January 30 Markman hearing and the close of document and interrogatory discovery on February 15.

³ Even if JohnsonFoils is correct that filing within the time provided by the scheduling order is "prima facie reasonable," Motion to Amend, at p. 5, any purported "prima facie" reasonableness is amply rebutted by JohnsonFoils' unexplained delay and the likely effect its delay will have on other deadlines specified in the Scheduling Order if its amendment is allowed.

D. JohnsonFoils' Unduly Delayed Motion to Amend Prejudices Voith

JohnsonFoils' undue delay in filing its Motion to Amend over four months after the time it first knew the facts cited as the basis for its proposed amendment prejudices Voith by disrupting the case schedule and requiring costly duplication of discovery.

JohnsonFoils' contention that "Voith has almost two months until February 15, 2008, to serve additional interrogatories and document requests" mischaracterizes the Scheduling Order. *See* Motion to Amend, at p. 8. In fact, the Scheduling Order requires that document and interrogatory discovery be *completed* by February 15, 2008. Thus, any additional document requests or interrogatories relating to the proposed claims would have to be made by January 16, 2008, one day from the filing of this Opposition, and a week before *briefing* on JohnsonFoils' Motion is likely to be completed. JohnsonFoils attempt to brush off these consequences of its undue delay by reference to Voith's broad discovery requests neglects the fact that JohnsonFoils stated in its objections to Voith's discovery requests that it would not respond to Voith's discovery requests to the extent that the definition of Accused Product is not relevant to the Patents-in-Suit. *See* JohnsonFoils' Objections, at p. 2.

In addition, with briefing on JohnsonFoils' unduly delayed Motion to Amend under way, Voith's Markman Brief, currently due January 16, 2008, could not possibly address issues raised in the *distinct claims* of the Unasserted Patents.

Also, having already invested significant resources in searching Voith's documents for documents either responsive to JohnsonFoils' document requests or supporting Voith's claims and defenses, that effort will have to be repeated to include issues relating to the three Unasserted Patents. Such documents include at least documents sufficient to demonstrate the

incorporation of the invention as claimed in the Unasserted Patents in commercially successful machines to support objective considerations of nonobviousness.

Such prejudice is undue because JohnsonFoils' delay is unexplained and inexcusable. Had JohnsonFoils asserted its newly proposed declaratory judgment counterclaims when it first knew the facts now cited to support them—prior to filing its original Answer and Counterclaims on August 13, 2008—Voith would have had the opportunity to either have the claims dismissed for lack of declaratory judgment jurisdiction or to at least conduct one pass through Voith's documents in search of relevant documents, instead of two.

Finally, JohnsonFoils' failure to cite any facts supporting declaratory judgment jurisdiction over the Unasserted Patents makes it likely that, if granted, JohnsonFoils' new counterclaims will require another full round of briefing on a Motion to Dismiss. JohnsonFoils' unexplained delay is thus likely to significantly disrupt the pre-trial schedule. Because of the limited time remaining in the term of the Patents-in-Suit, such delays would unfairly benefit JohnsonFoils at Voith's expense.

III. JOHNSONFOILS' MOTION TO AMEND SHOULD BE DENIED EVEN IF JOHNSONFOILS INTENDS AT SOME FUTURE TIME TO MOVE FOR CONSOLIDATION OF ITS SEPARATELY FILED ACTION RELATING TO THE UNASSERTED PATENTS

JohnsonFoils' Motion to Amend should be denied even if JohnsonFoils intends, at some time in the future, to seek addition of its declaratory judgment counterclaims with this action by filing a Motion for Consolidation. As explained above, JohnsonFoils' new declaratory judgment counterclaims are futile for failing to identify a dispute relating to the Unasserted Patents. As a result, the possibility that JohnsonFoils' claims in the separately filed action will survive a motion to dismiss in a form sufficient to justify consolidation of the two actions is purely speculative.

Even if JohnsonFoils' Unasserted Patent declaratory claims survive a motion to dismiss, the economies of trying any common factual issues is more than offset by the likely prejudice to Voith resulting from JohnsonFoils' undue delay. Under Fed. R. Civ. P. 42(a), separate actions involving common questions of law or fact may, in the discretion of the Court, be consolidated for trial. *See La Chemise La Coste v. Alligator Co., Inc.*, 60 F.R.D. 164, 175 (D. Del. 1973). Although such common issues are a prerequisite to consolidation, the mere existence of these issues does not require a joint trial as a matter of course. Instead the Court must balance the savings of time and effort gained through consolidation against the inconvenience, delay or expense that might result from simultaneous disposition of the separate actions. *See Clipay Corp. v. Newell Co., Inc.*, 527 F.Supp. 733, 735-36 (D. Del. 1981) (denying Motion to Consolidate actions involving identical patent asserted against different infringers); 9 Wright & Miller, Federal Practice and Procedure: Civil § 2383 at 259-60.

Because of JohnsonFoils' delay in asserting its newly proposed counterclaims, it is unlikely that the new claims can be incorporated into the current action without substantial disruption, including at least a full round of briefing on jurisdictional issues and redoing document and interrogatory discovery. However, to the extent that the claims of the separately filed action survive a Motion to Dismiss, any economy from consolidating aspects of the two actions are best addressed by a timely filed Motion for Partial Consolidation.

CONCLUSION

For the foregoing reasons, Voith respectfully requests that JohnsonFoils' Motion to Amend be denied.

Respectfully submitted,

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Dated: January 14, 2008

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CERTIFICATE OF SERVICE

I, Adam W. Poff, hereby certify that on January 14, 2008, I caused to be electronically filed a true and correct copy of the foregoing document with the Clerk of the Court using CM/ECF, which will send notification that such filing is available for viewing and downloading to the following counsel of record:

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Exhibit 1



US005972168A

United States Patent [19]

Egelhof et al.

[11] Patent Number: **5,972,168**[45] Date of Patent: **Oct. 26, 1999**

[54] TWIN WIRE FORMER

[75] Inventors: Dieter Egelhof, Klaus Henseler, both of Heidenheim, Germany; Werner Kade, Neenah, Wis.; Albrecht Melnecke, Heidenheim, Germany; Wilhelm Wanke, Heidenheim, Germany; Hans-Jürgen Wulz, Heidenheim, Germany; Rudolf Bück, deceased, late of Heidenheim, Germany, by Elsie Bück, legal representative

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[73] Assignee: Voith Sulzer Papiertechnik Patent GmbH, Germany

FOREIGN PATENT DOCUMENTS

3138133 9/1981 Germany .
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[21] Appl. No.: 09/161,138

[22] Filed: Sep. 25, 1998

Related U.S. Application Data

[62] Continuation of application No. 09/023,435, Feb. 13, 1998, which is a continuation of application No. 08/556,769, Nov. 2, 1995, Pat. No. 5,718,805, which is a continuation of application No. 08/286,948, Aug. 8, 1994, Pat. No. 5,500,091, which is a continuation of application No. 08/055,918, Apr. 29, 1993, Pat. No. 5,389,206, which is a continuation of application No. 07/773,965, abandoned, filed as application No. PCT/EP90/01313, Sep. 8, 1990.

[51] Int. Cl.⁶ D21F 1/00

[52] U.S. Cl. 162/203; 162/301

[58] Field of Search 162/203, 300,
162/301, 303, 348, 352

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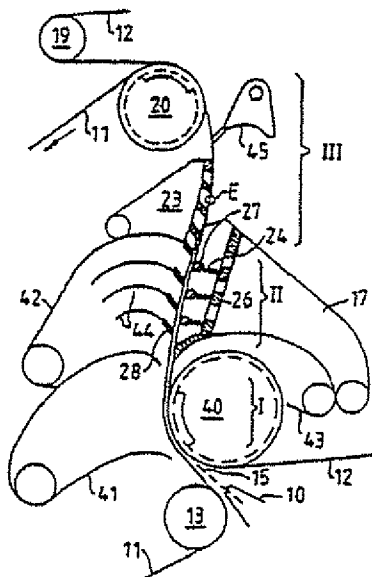
Primary Examiner—Karen M. Hastings

Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen, LLP

[57] ABSTRACT

In a twin-wire former for the production of a paper web, two wire belts (11 and 12) together form a twin-wire zone which is divided into three sections (I, II and III). In the first section (I) the two wires (11, 12) travel over a curved forming shoe (16). They form there a wedge-shaped inlet slot (15) with which a headbox (10) is directly associated. In the second section (II), several resiliently supported strips (27) rest against the lower wire (11) and between each of said strips (27) a rigidly mounted strip (28) rests against the upper wire (12). In the third section (III) both wire belts (11, 12) pass over another curved forming shoe (23).

8 Claims, 2 Drawing Sheets



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Fig.1

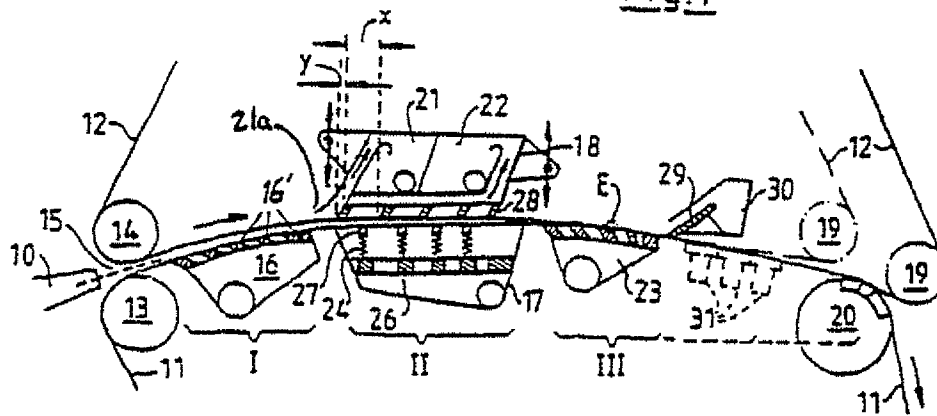


Fig.2

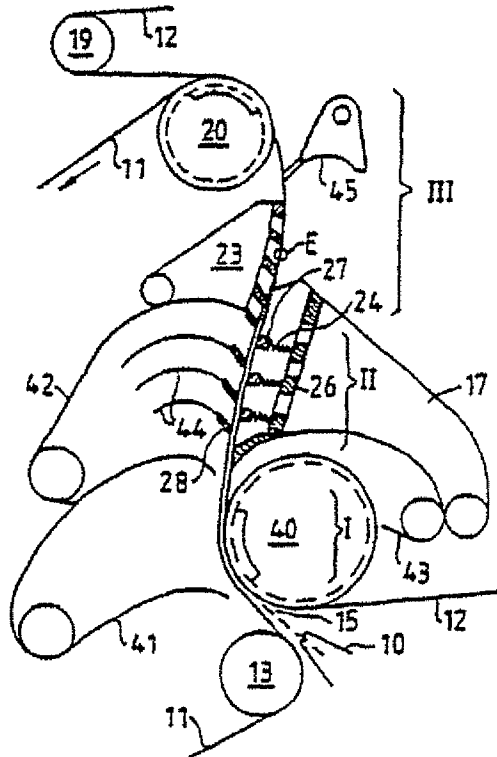
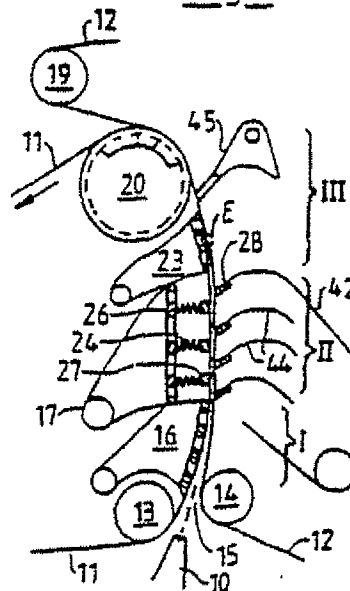


Fig.3

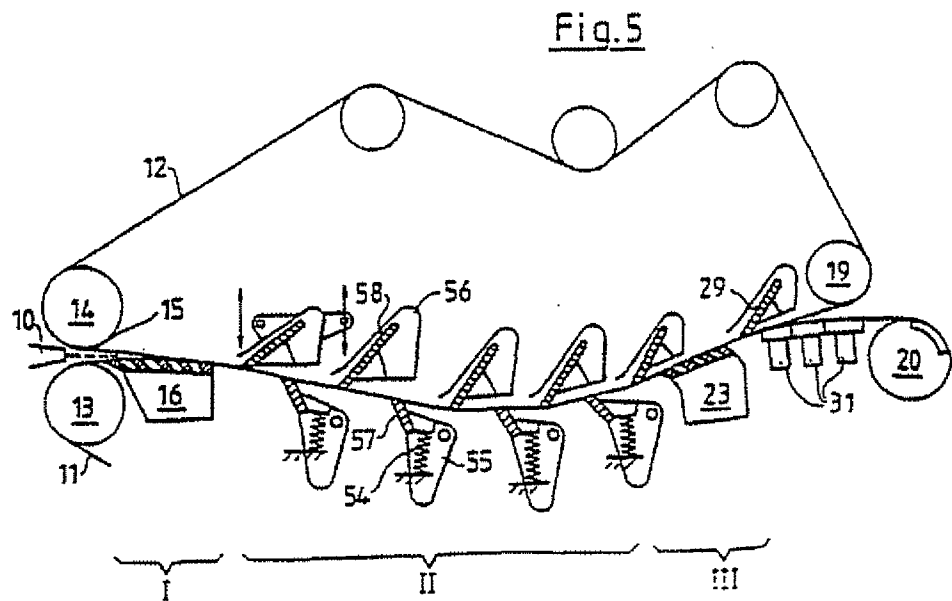
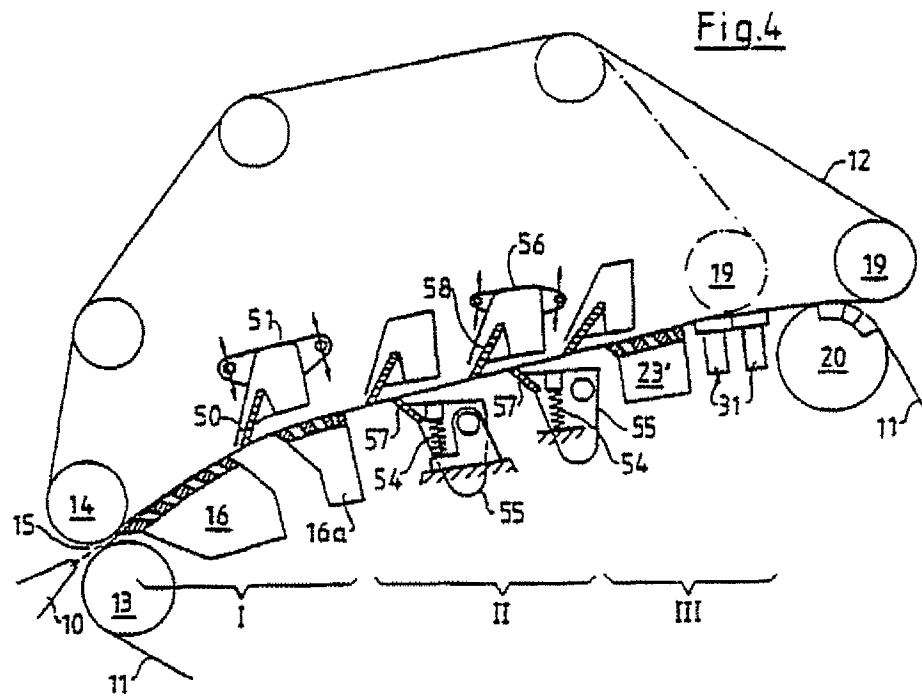


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TWIN WIRE FORMER RELATED APPLICATIONS

This is a continuing application of, and hereby incorporates by reference the entire disclosure of, application Ser. No. 09/023,435, filed Feb. 13, 1998, allowed, which is a continuing application of Ser. No. 08/556,769, filed Nov. 2, 1995, now Pat. No. 5,718,805, which is a continuing application of Ser. No. 08/286,948, filed Aug. 8, 1994, now Pat. No. 5,500,091, which is a continuing application of Ser. No. 08/055,918, filed Apr. 29, 1993, now Pat. No. 5,389,206, which is a continuing application of Ser. No. 07/773,965, filed Nov. 12, 1991, now abandoned, filed as PCT/EP90/01313 on Sept. 8, 1990, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to a twin-wire former for the production of a fiber web, in particular a paper web, from a fiber suspension. The invention proceeds from the basis of the twin-wire former known from British Patent 1 125 906. The features indicated in the patent include a twin wire former for producing a fiber web and particularly a paper web from a fiber suspension. Two web forming wire belts, in the form of endless loops, travel together to form a twin wire zone. The web travels between and along the path of the wire belts through the twin wire zone. The twin wire zone has three sections and the elements in those three sections are described below. The patent describes features that state, in other words, that the forming of the fiber web from the pulp suspension fed from the headbox takes place exclusively between two wire belts. Thus, there is no so-called single-wire pre-drainage path. In a first section of the twin-wire zone, the two wire belts together form a wedge-shaped inlet slot; a jet of pulp slurry coming from the headbox discharges into it. The jet strikes the two wire belts at a place where they pass over a curved drainage element; in the case of the aforementioned British patent, this is a stationary, curved forming shoe. Its curved wire guide surface is formed of a plurality of strips with drainage slots between them. This forming shoe is followed (in a second section of the twin-wire zone) by a drainage strip arranged in the other wire loop and, behind the latter, by a drainage strip arranged in the first-mentioned wire loop (and formed by a first suction box). Finally, in a third section of the twin-wire zone there are a plurality of stationary drainage elements developed as flat suction boxes.

It has been attempted for decades with twin-wire formers of the known type to produce fiber webs (in particular, paper webs) of the highest possible quality with relatively high operating speeds. Due to the forming of the web between two wires, the result, in particular, is obtained that the final fiber web has substantially the same properties on both sides (little "two-sidedness"). However, it is difficult to obtain as uniform as possible a distribution of the fibers in the final fiber web. In other words, it is difficult to obtain a good "formation" since while the web is formed, there is always the danger that fibers will agglomerate and form flocculations. Therefore, it is attempted to form a jet of pulp slurry which pulp slurry is as free as possible of flocculations in the headbox (for instance, by means of a turbulence producer). It is, furthermore, endeavored so to influence the drainage of the fiber suspension during the web-forming that "reflocculation" is avoided as far as possible or that, after possible flocculation, a "deflocculation" (i.e. a breaking up of the flocculations) takes place.

It is known that a curved drainage element arranged in the first section of the twin-wire zone and, in particular, a

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stationary curved forming shoe developed in accordance with the aforementioned British Patent 1 125 906 counteracts the danger of reflocculation. This is true also of the drainage strips arranged in the British Patent in the second section of the twin-wire zone. Nevertheless, the danger of reflocculation is not completely eliminated in the arrangement according to said British Patent. Since the number of drainage strips there is very small, a large part of the web-forming takes place in the region of the following flat-suction boxes. They, to be sure, are of high drainage capacity so that the web-forming can be completed in the region of the last flat suction boxes (i.e. the so-called main drainage zone, in which a part of the fiber material is still in the form of a suspension, terminates in the region of the flat suction box). The flat suction boxes, however, are not able to avoid reflocculation or to break up flocculations which have already occurred.

In order to control these last-mentioned difficulties, a web-forming device known under the name of "Duoformer D" has been developed (TAPPI Proceedings 1988 annual meeting, pages 75 to 80). This known web-forming device is part of a twin-wire former which has a single-wire pre-drainage zone. In the twin-wire zone there are provided, in the one wire loop, a plurality of strips which are fixed in position but adjustably supported, namely, on the bottom of a suction box which drains in upward direction. Furthermore, a plurality of resiliently supported strips are provided in the other wire loop. By this resilience of the last-mentioned strips, the following result can be obtained: For example, upon an increase of the amount of suspension entering between the two wire belts, the flexibly supported strips can move away somewhat. In this way, the danger (which is present when only firmly supported strips are used) is eliminated of a backing up taking place in the fiber suspension in front of the strips. Such a backing up could destroy the fiber layers which have been formed up to then on the two wire belts. In other words, with this known web-forming device, a drainage pressure, once established, remains constant due to the resiliently supported strips even upon a change in the amount of suspension fed or upon a change in the drainage behavior of the fiber suspension. Therefore, automatic adaptation of the web-forming device to said changed conditions occurs.

With this known web-forming device, fiber webs of relatively good formation can also be formed. With respect to this, however, the demands have increased considerably recently, so that further improvements are desirable.

SUMMARY OF THE INVENTION

The object of the invention is so to develop a twin-wire of the aforementioned kind that the quality of the fiber web produced is further improved, particularly with respect to its formation (cloudiness), and that the twin-wire former can easily be adapted to different operating conditions (for instance, with regard to quantity and drainage behavior of the fiber suspension).

This object is achieved by the features set forth below in particular, there is a respective drainage strip above each of the two wire belts in the second section of the twin wire zone, and at least one of the two drainage strips is supported resiliently against the respective wire belt while the other may or may not be resiliently supported, and typically is rigidly supported against the respective wire belt. Preferably, there are at least two of the drainage strips and often more against each of the wire belts. The drainage strips against one belt are offset along the path of the wire belts with

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respect to the drainage strips against the other belt, providing a zig zag or staggered array, and the drainage strips against at least one of the belts are resiliently supported.

The inventors have found that a combination of known features, namely:

- A. Twin-wire former without a single-wire pre-drainage zone or at least without a single-wire pre-drainage zone of any substantial length such as to cause any appreciable pre-drainage
- B. Start of the drainage in the twin-wire zone at a preferably curved drainage element, for instance on a rotating forming cylinder or, even better, on a curved stationary forming shoe
- C. Further drainage in the twin-wire zone between strips which are arranged along a "zig-zag" line, the strips which rest against the one wire belt being resiliently supported, leads to an extremely high increase in the quality of the finished fiber web, so that it satisfies even the highest requirements. At the same time, the twin-wire former of the invention is insensitive to changes in the amount of suspension fed and to changes in the drainage behavior of the fiber suspension. Experiments have shown that it is possible by the invention to obtain both a high increase in quality with respect to the formation and also good values with regard to the retention of fillers and fines. In contradistinction to this, in the known double-wire formers it is constantly found that there is a strong reduction in the retention upon an improvement in the formation.

It was, furthermore, found in experiments that in the second section of the twin-wire zone the number of strips can be considerably reduced as compared with the "Duo-former D". However, this number is substantially greater than in the case of the twin-wire former known from British Patent 1 125 906. It is advantageous to increase the distance between adjacent strips as compared with the "Duo-former D". In particular, the drainage strips above each one of the wire belts are of a thickness along the path of the wire belts and the spacing between adjacent strips above each wire belt is a minimum of about three times the strip thickness.

To be sure, from German OS 31 38 133, FIG. 3, a twin-wire former is known the twin-wire zone of which is provided in a first section with a curved stationary drainage element and in a second section with strips arranged along a "zig-zag" line, which strips may also be resiliently supported and there being a relatively large distance between them. However, in that case, in front of the twin-wire zone there is a single-wire pre-drainage zone in which the forming of the web starts initially only in a lower layer of the fiber suspension fed while the upper layer remains liquid and tends very strongly to flocculation. It has been found that these flakes cannot be broken up again to the desired extent in the following twin-wire zone. Another disadvantage is that the twin-wire zone is diverted by a guide roll (14b) behind the second section. This results (due to the so-called table-roll effect) in a further drainage which is uneven over the width of the web and thus in undesired variations in the quality of the web (recognizable, for instance, by disturbing longitudinal stripes).

BRIEF DESCRIPTION OF THE DRAWINGS

Other developments of the invention will be explained below with reference to embodiments which are shown in the drawing. Each of FIGS. 1 to 5 shows in simplified diagrammatic form one of the different embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The twin-wire former shown in FIG. 1 has a substantially horizontally extending twin-wire zone; this zone comprises

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three sections I, II and III arranged one behind the other. The endless wire belts (lower wire 11 and upper wire 12), shown only in part, travel in the direct vicinity of a headbox 10 over, in each case, a breast roll 13 and 14 respectively, so that the two wire belts together form a wedge-shaped entry slot 15 at the start of the twin-wire zone. The jet pulp discharged by the headbox 10 comes into contact with the two wire belts 11 and 12 only at the place where the lower wire 11 in the first section I of the twin-wire zone travels over a stationary curved forming shoe 16. The curved travel surface thereof is formed of several strips 16' with drainage slits present between them. The distance between the two breast rolls 13 and 14 is variable. The forming shoe 16 can be operated with or without vacuum. Additionally, although it is preferable that the forming shoe 16 be curved, a straight forming shoe may also be used in certain situations.

In the second section II of the twin-wire zone, the two wire belts 11 and 12 (with the partially still liquid fiber suspension present between them) travel between a lower drainage box 17 and an upper drainage box 18. In the lower drainage box 17 there are a row of at least two strips 27 (preferably of approximately rectangular cross section) which are pressed from below resiliently against the lower wire 11. For this purpose, they are supported, for instance, on springs 24 (or pneumatic pressure cushions) on a, preferably water-permeable, plate. It is obvious that the force of the springs (or of the pressure prevailing in the pressure cushions) is individually adjustable.

The upper drainage box 18 is suspended on both the front and rear ends on vertically displaceable support elements as indicated diagrammatically by double arrows. On its lower side, there is a row of at least three strips 28 of preferably parallelogram cross section which rest against the upper side of the upper wire 12 and are rigidly attached to the box 18. Above the strips 28, a front vacuum chamber 21 and a rear vacuum chamber 22 are present in the drainage box 18.

Each of the upper strips 28 scrapes off water from the wire 12. Accordingly, the amount of water scraped off decreases in the direction of flow of the wire 12 from strip to strip. The drainage water from each of the strips 28 except the drainage water scraped off by the first strip may be drained away jointly. However, it is disadvantageous to also include the drainage water from the first strip 28 since this generally would disturb the operation of the other strips. Accordingly, a vertical channel 21a is positioned in front of the first upper strip 28 to carry away or collect the water scraped off by the first strip 28.

In the region of the forming shoe 16, a part of the water of the fiber suspension is led off downward; another part penetrates due to the tension of the upper wire 12 upwards through the upper wire and is deflected by the furthest in front of the strips 28 into the front vacuum chamber 21. The water passing upward between the upper strips 28 enters into the rear vacuum chamber 22. The water penetrating between the lower strips 27 through the lower wire 11 is led off downward. Between adjacent upper drainage strips 28 there is a minimum distance X of about three times the thickness Y of the strips. The same is true of the lower resiliently supported strips 27. It is important that each of the strips 27 and 28 lies in the region of a space between two opposite strips so that a "zig-zag" arrangement (i.e. non-opposing relationship) is present. Also, as seen in FIG. 1, the first one of the strips 28 is located upstream of the first one of the strips 27. The two wires 11 and 12 preferably travel on a straight path through section II. Gentle curvature of this section of the path is, however, also possible; see FIGS. 2 and 5. Differing from FIG. 1, the resiliently supported strips

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could also be arranged in the upper box 18 and the firmly supported strips in the lower box 17. In the third section III of the twin-wire zone, both wire belts 11 and 12 travel over another preferably curved forming shoe 23 which (as shown) is arranged preferably in the lower wire loop 11. Behind it, an additional strip 29 with vacuum chamber 30 can be arranged in the loop of the upper wire 12. Furthermore, flat suction boxes 31 can be present in the loop of the lower wire. There (as is shown by dash-dot lines) the upper wire 12 can be separated by means of a guide roll 19 from the lower wire 11 and from the fiber web formed. Lower wire and fiber web then travel over a wire suction roll 20. The guide roll 19 can, however, also lie further back, so that the upper wire 12 is separated from the lower wire 11 only on the wire suction roll 20.

It is important that two drainage boxes 17 and 18 with the alternately resiliently and firmly supported ledge strips 27 and 28 lie not in the front or the rear sections but in the middle section II of the twin-wire zone, since only here can they develop their full effect, namely, intensive drainage of the fiber suspension fed while retaining the fine flocculation-free fiber distribution. This is achieved in the manner that the corresponding wire belt is imparted a slight (scarcely visible) deflection on each strip so that turbulence is constantly produced in the still liquid part of the fiber pulp. For success it is, however, also decisive that previously, in section I, a known pre-drainage towards both sides has already taken place and that this also takes place with the greatest possible retention of the flocculation-free condition of the fiber suspension.

For this two-sided pre-drainage, a stationary preferably curved forming shoe is provided in the first section I of the twin-wire zone (in accordance with FIGS. 1 and 3-5) whenever it is a question of satisfying the highest quality demands with respect to the formation. This effect of the forming shoe is due to the fact that at least the one wire belt travels polygonally from strip to strip, each strip not only leading water away but also producing turbulence in the pulp which is still liquid. With such a forming shoe, it is, however, difficult at times to obtain a stable operating condition upon the starting of the paper machine. Therefore, it may be advantageous to provide a known forming roll 40 in accordance with FIG. 2 in Section I instead of the stationary forming shoe and the breast roll lying in front of it. This possibility will be utilized when, in particular, the highest productivity is demanded from the paper manufacturing machine.

In the third section III, the aforementioned strip 29 can serve either solely to lead away water upwards or, in addition, for the further production of turbulence (for further improvement in quality). The latter is possible if a part of the fiber pulp is still in liquid condition at this place.

In FIGS. 1 to 3, the distance between the two wires 11 and 12 in the twin-wire zone has been shown greatly exaggerated. By this, it is intended to make it clear that the two wires 11 and 12 converge towards each other over a relatively long path within the twin-wire zone. This makes it clear that the process of web-forming on the first forming shoe 16 (in Section I) commences relatively slowly and is completed only in Section III. In this connection, the end of the main drainage zone in which the two wires converge towards each other (and thus, the end of the web-forming process) can lie approximately in the center of the wrapping zone of the second forming shoe 23, as is indicated, merely by way of example, in FIGS. 1 to 3. The end of the wire convergence is symbolically indicated there by the point E; the solids content of the paper web has reached there approximately

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the value of 8%. This point can, however, also lie, for instance, on one of the flat suction boxes 31. Behind this point, it is attempted further to increase the solids content, if possible even before the separation of the two wires. One goal is, namely, for the separation of the wires to take place with the highest possible solids content of the web so that as few fibers as possible are torn out of the web upon the separation. The nature and number of the drainage elements necessary for this within the twin-wire zone may, however, differ greatly and is dependent, among other things, on the type of paper and the raw-material components thereof, as well as on the operating speed.

The embodiments shown in FIGS. 2 and 3 differ from the others primarily by the fact that the twin-wire zone rises substantially vertically upward in the direction of travel of the wires. In this way, the removal of the water withdrawn from the fiber suspension is simplified since the water can be discharged relatively uniformly towards both sides. No vacuum chambers are required in particular in the central section II of the twin-wire zone. To be sure, the forming roll 40 of FIG. 2 is, as a rule, developed as a suction roll. The forming shoes 16, 23, particularly those arranged in the third section III, can, if necessary, be provided with a suction device.

Further elements of the twin-wire former shown in FIG. 2 are water-collection containers 41, 42 and 43, guide plates 44 associated with the fixed strips 28, and a water removal strip 45. The other elements are provided with the same reference numbers as the corresponding elements in FIG. 1. The same is true with regard to FIG. 3. One possible modification of FIG. 3 can consist therein that, instead of the wire suction roll 20, a forming roll is provided, and instead of the guide roll 19 the wire suction roll. A similar arrangement is known from German Utility Model 88 06 036 (Voith File: P 4539). Aside from this exception and aside from the embodiment according to FIG. 2 (with forming roll 40), the invention will, however, be used whenever possible so to design the twin-wire former that the relatively expensive forming roll (as to purchase and operation) can be dispensed with. Thus, as a rule, the wire suction roll 20 is present as the sole suction roll. Furthermore, in all embodiments of the invention it can be seen to it that no guide roll which deflects the twin-wire zone (and has the above-mentioned injurious table-roll effect) is present.

The embodiment of FIG. 4 differs from FIG. 1 among other things by the fact that, in the first section I of the twin-wire zone, a second curved stationary forming shoe 16a is arranged in the loop of the lower wire 11 behind and spaced from a first curved stationary forming shoe 16. Furthermore, in the loop of the upper wire 12 in the region between the two stationary forming shoes 16 and 16a there is provided an individual strip 50 which in known manner is part of a vacuum chamber 51. This vacuum chamber 51, similar to the upper drainage box 18 of FIG. 1, is suspended on its front and rear ends in vertically displaceable mounts. In this way, both the depth of penetration of the strip 50 into the path of travel of the upper wire 12 as well as the angle of attack of the strip 50 can be varied. With slight depth of penetration, the strip 50 serves solely for removal of water, while with greater depth of penetration it serves, in addition, for the production of turbulence in the suspension and, thus, for improvement of the formation. By the presence of two separate forming shoes 16 and 16a, the pre-drainage on both sides is temporarily interrupted; it is only continued after the strip 50 has removed from the upper wire 12 the water which has penetrated upward on the first forming shoe 16. In this way, higher operating speeds are possible.

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Another difference from FIG. 1 is that, in the second section II of the twin-wire zone, the lower, flexibly supported strips 57 and the upper, firmly supported strips 58 are developed as individual strips. This means that each strip has its own supporting body 55/56. The lower strip-supporting bodies 55 are swingably mounted, the strip 57 being pressed resiliently by the force of springs 54 against support bottom of the lower wire 11. The supporting body 56 of each of the upper strips 58 is developed as vacuum chamber in the same way as that of the strip 50. The suspension of these vacuum chambers 56 corresponds to that of the vacuum chamber 51. It is important that each of the strips 57 and 58 rest with a given force of application (corresponding to the suspension pressure) against its wire belt 11 or 12. The strips 57 and 58 are adjusted in such a manner that a slight deflection of the wire belts takes place preferably on each strip. Due to the resilient supporting of the lower strips 57, the adjustment, once effected, is insensitive to changes in the quantity or quality of pulp, so that no backing up takes place in front of the strips and, nevertheless, an effective introduction of turbulence forces into the fiber suspension takes place. In contradistinction to FIGS. 1 to 3, there is the possibility of adjusting each one of the strips 57/58 individually with respect to position in height and inclination relative to the travel path of the wire. In this way, one can even better control the quality of the paper produced, with respect to both the formation and the nature of its surface (printability). Differing from FIG. 4, the upper strips 58 could be supported resiliently and the lower strips 57 stationary. Another alternative could consist therein that not only the upper strips 58 but also the lower strips 57 are fastened in vertically displaceable mounts (as shown on the vacuum chamber 51). In such case, the springs 54 might possibly be eliminated.

Another difference between FIGS. 1 and 4 resides in the fact that in FIG. 4 the twin-wire zone rises in the direction of travel of the wires upwards with an inclination of, on the average, about 20° with respect to the horizontal. In this way, it is possible to keep the entire height of the twin-wire former relatively slight. In the third section III of the twin-wire zone, a flat forming shoe 23' is provided rather than a curved one, differing from FIG. 1. The separation of the upper wire 12 from the lower wire and the fiber web formed can take place, as in FIG. 1, on one of the flat suction boxes 31. Instead of this, however, the upper wire 12 can also be conducted up to the wire suction roll 20. There, as shown, it can wrap around a small part (or, alternatively, a larger part) of the circumference of the wire suction roll and then be returned via the reversing roll 19.

In the embodiment shown in FIG. 5, the twin-wire zone, as a whole, extends substantially in horizontal direction. The individual elements are substantially the same as in the embodiment of FIG. 4. However, there is the difference that the drainage strips 57 and 58 lying in the second section II of the twin-wire zone are arranged along a downwardly curved path of the twin-wire zone. Accordingly, an upwardly curved forming shoe 16, 23 is provided in the first section I and in the third section III of the twin-wire zone. This embodiment is advisable, in particular, for the modernizing of existing Fourdrinier paper machines.

The embodiments shown have the feature in common that, in the second section II of the twin-wire zone, there are present preferably n flexibly supported strips 27/57 and $n+1$ rigidly supported strips. However, it is also possible to make the number of flexibly supported strips equal to or greater by one than the number of rigidly supported strips. Instead of a rigidly supported strip, a feed or discharge edge of a drainage box can also be provided. The minimum number n

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of flexibly supported strips is two (see FIG. 4). However, three or four flexibly supported strips are preferred.

What is claimed is:

1. A method for the production of a paper web from a fiber suspension in a twin wire former comprising:
 - causing first and second web forming wire belts to travel along a path together to form a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, each wire belt forming an endless loop;
 - feeding the wire belts across a single forming roll at the start of the path through the twin wire zone;
 - supporting the wire belts such as to form a wedge shaped entrance slot into the twin wire zone;
 - supplying a fiber suspension from a headbox directly to the wedge shaped entrance slot of the twin wire zone;
 - draining water from the fiber suspension by means of the forming roll in order to start the forming of the web from the fiber suspension;
 - feeding the wire belts with the fiber suspension and the web being generated therebetween downstream of the forming roll between a plurality of first drainage strips, which are positioned within the loop of the first wire belt for contacting the first wire belt, and a plurality of second drainage strips, which are positioned within the loop of the second wire belt for contacting the second wire belt, the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship;
 - resiliently supporting the first drainage strips against the first wire belt that the strips contact;
 - rigidly supporting the second drainage strips against the second wire belt;
 - feeding the wire belts with the web therebetween downstream of said drainage strips across a stationary drainage element and then across a suction roll in the twin wire zone such that as the wire belts travel over the stationary drainage element and over said suction roll, water is drained through the wire belt in contact with said stationary drainage element and with said suction roll; and
 - maintaining the twin wire zone apart from said single forming roll and said suction roll free of rolls which would deflect the twin wire zone.
2. The method of claim 1, further comprising supplying a vacuum in the area of the second drainage strips.
3. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:
 - first and second web forming wire belts which travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;
 - each wire belt forming an endless loop;
 - the twin wire zone having a first section which includes a single forming roll at the start of the path of the wire belts through the twin wire zone; supports which support the wire belts for forming a wedge shaped entrance slot into the first section;
 - a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone;

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said single forming roll having an open surface to enable drainage of water from the fiber suspension and being curved along the path of the wire belts through the twin wire zone, the single forming roll being engaged by one of the wire belts and being arranged for curving the path of both wire belts around the single forming roll after the entrance of the suspension into the entrance slot;

the twin wire zone having a second section following the first section along the path of the wire belts through the twin wire zone; in the second section, a plurality of the first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; a first strip support which resiliently supports the first drainage strips against the first wire belt that the first strips contact;

a second strip support which supports the second drainage strips rigidly against the second wire belt;

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; drainage elements in the third section, for being engaged by one of the wire belts as the wire belts travel over the drainage elements, the drainage elements including at least one stationary dewatering element followed by a suction roll and having an open surface to enable water to be drained through the wire belt in contact therewith; and

the twin wire zone apart from said single forming roll and said suction roll being free of rolls which deflect the twin wire zone.

4. The twin-wire former of claim 3, further comprising a supplier of vacuum in the area of the second drainage strips.

5. A method for the production of a paper web from a fiber suspension in a twin wire former comprising:

causing first and second web forming wire belts to travel along a path together to form a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, each wire belt forming an endless loop;

feeding the wire belts across a stationary curved forming shoe at the start of the path through the twin wire zone;

supporting the wire belts such as to form a wedge shaped entrance slot into the twin wire zone;

supplying a fiber suspension from the head box directly to the wedge shaped entrance slot of the twin wire zone;

draining water from the fiber suspension by means of the forming shoe in order to start the forming of the web from the fiber suspension;

feeding the wire belts with the fiber suspension and the web being generated therebetween downstream of the forming shoe between a plurality of first drainage strips, which are positioned within the loop of the first wire belt for contacting the first wire belt, and a plurality of second drainage strips, which are positioned within the loop of the second wire belt for contacting the second wire belt, the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship;

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resiliently supporting the first drainage strips against the first wire belt that the strips contact;

rigidly supporting the second drainage strips against the second wire belt;

feeding the wire belts with the web therebetween downstream of said drainage strips across a stationary drainage element and then across a suction roll in the twin wire zone such that as the wire belts travel over the stationary drainage element and the suction roll, water is drained through the wire belt in contact with said stationary drainage element and the suction roll; and maintaining the twin wire zone apart from said suction roll free of rolls which would deflect the twin wire zone.

6. The method of claim 5, further comprising supplying a vacuum in the area of the second drainage strips.

7. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts which travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section which includes a stationary curved forming shoe at the start of the path of the wire belts through the twin wire zone; supports which support the wire belts for forming a wedge shaped entrance slot into the first section;

a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone;

said stationary curved forming shoe having an open surface to enable drainage of water from the fiber suspension and being curved along the path of the wire belts through the twin wire zone, the forming shoe being engaged by one of the wire belts and being arranged for curving the path of both wire belts around the forming shoe after the entrance of the suspension into the entrance slot;

the twin wire zone having a second section following the first section along the path of the wire belts through the twin wire zone; in the second section, a plurality of the first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belts; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; a first strip support which resiliently supports the first drainage strips against the first wire belt that the first strips contact;

a second strip support which supports the second drainage strips rigidly against the second wire belt;

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a stationary drainage element followed by a suction roll in the third section, for being engaged by one of the wire belts as the wire belts travel over the stationary drainage element and said suction roll, the stationary drainage element and said suction

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roll having an open surface to enable water to be drained through the wire belt in contact therewith; and the twin wire zone apart from said suction roll being free of rolls which deflect the twin wire zone.

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8. The twin-wire former of claim 7, further comprising a supplier of vacuum in the area of the second drainage strips.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 5,972,168
DATED : October 26, 1999
INVENTOR(S) : Egelhof, et. al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Please correct the first name of the 7th inventor's legal representative as follows:
[75] Else Bück, legal representative

Please add the following missing priority data:
[30] Foreign Application Priority Data
August 22, 1989 [DE] Germany....P 39 27 597.3

Please correct the Related U.S. Application Data as follows:

[62] Continuation of application No. 09/023,435, Feb. 13, 1998, which is a continuation of application No. 08/556,769, Nov. 2, 1995, Pat. No. 5,718,805, which is a continuation of application No. 08/286,948, Aug. 8, 1994, Pat. No. 5,500,091, which is a continuation of application No. 08/055,918, April 29, 1993, Pat. No. 5,389,206, which is a continuation of application No. 07/773,965, Nov. 12, 1998, abandoned, filed as application No. PCT/EP90/01313, Aug. 9, 1990.

Signed and Sealed this
Thirtieth Day of May, 2000

Attest:



Q. TODD DICKINSON

Attesting Officer

Director of Patents and Trademarks

Exhibit 2



US005718805A

United States Patent [19]

Egelhof et al.

[11] **Patent Number:** 5,718,805[45] **Date of Patent:** *Feb. 17, 1998[54] **TWIN WIRE FORMER**

[75] **Inventors:** Dieter Egelhof; Klaus Henseler, both of Heidenheim, Germany; Werner Kade, Neenah, Wis.; Albrecht Meinecke, Heidenheim, Germany; Wilhelm Wanke, Heidenheim, Germany; Hans-Jürgen Wulz, Heidenheim, Germany; Rudolf Bück, deceased, late of Heidenheim, Germany, by Elise Bück, legal representative

[73] **Assignee:** J. M. Voith GmbH, Heidenheim, Germany

[*] **Notice:** The term of this patent shall not extend beyond the expiration date of Pat. No. 5,500,091.

[21] **Appl. No.:** 556,769

[22] **Filed:** Nov. 2, 1995

Related U.S. Application Data

[63] Continuation of Ser. No. 286,948, Aug. 8, 1994, Pat. No. 5,500,091, which is a continuation of Ser. No. 55,918, Apr. 29, 1993, Pat. No. 5,389,206, which is a continuation of Ser. No. 773,965, filed as PCT/EP90/01313, Sep. 8, 1990, abandoned.

[30] **Foreign Application Priority Data**

Aug. 22, 1989 [DE] Germany 39 27 597.3

[51] **Int. Cl.⁶** D21F 1/00

[52] **U.S. Cl.** 162/301; 162/300

[58] **Field of Search** 162/203, 300, 162/301, 303, 348, 352

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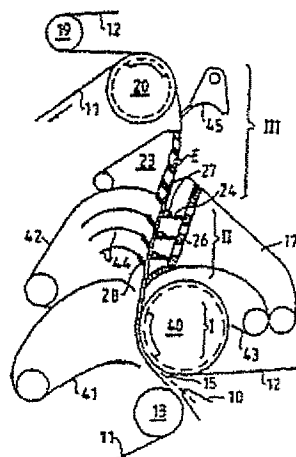
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Primary Examiner—Karen M. Hastings
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen, LLP

[57] **ABSTRACT**

In a twin-wire former for the production of a paper web, two wire belts (11 and 12) together form a twin-wire zone which is divided into three sections (I, II and III). In the first section (I) the two wires (11, 12) travel over a curved forming shoe (16), or a forming roll (40). They form there a wedge-shaped inlet slot (15) with which a headbox (10) is directly associated. In the second section (II), several resiliently supported strips (27) rest against the lower wire (11) and between each of said strips (27) a rigidly mounted strip (28) rests against the upper wire (12). In the third section (III) both wire belts (11, 12) pass over another curved forming shoe (23).

5 Claims, 2 Drawing Sheets



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Fig.1

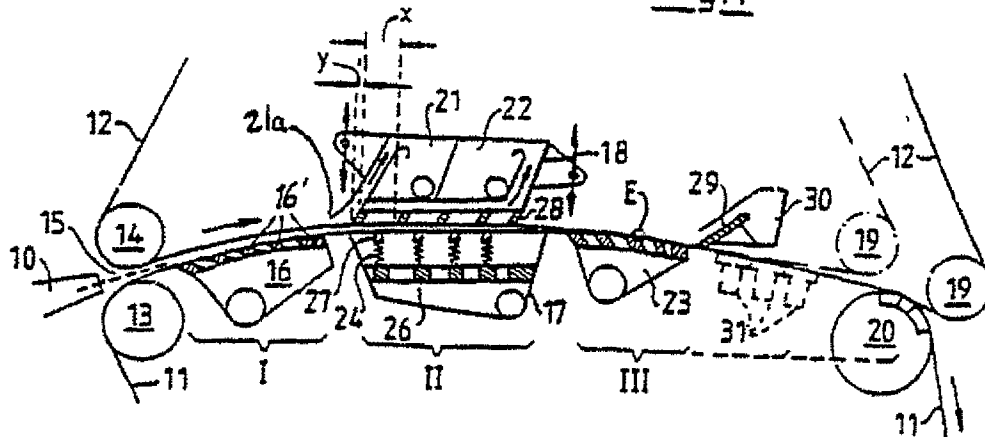


Fig.2

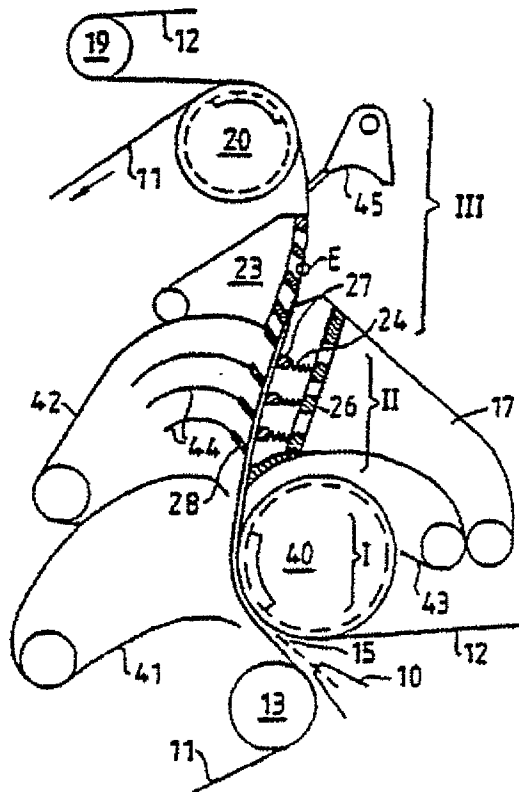
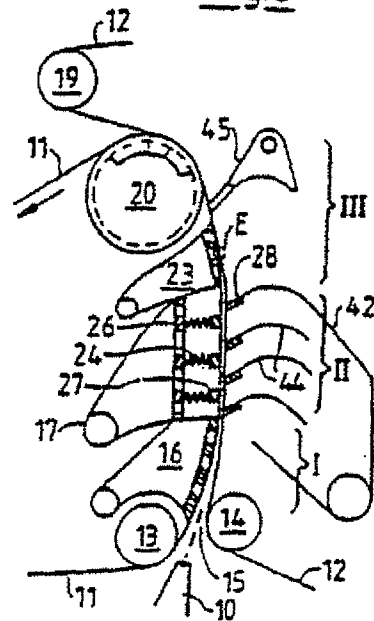


Fig.3

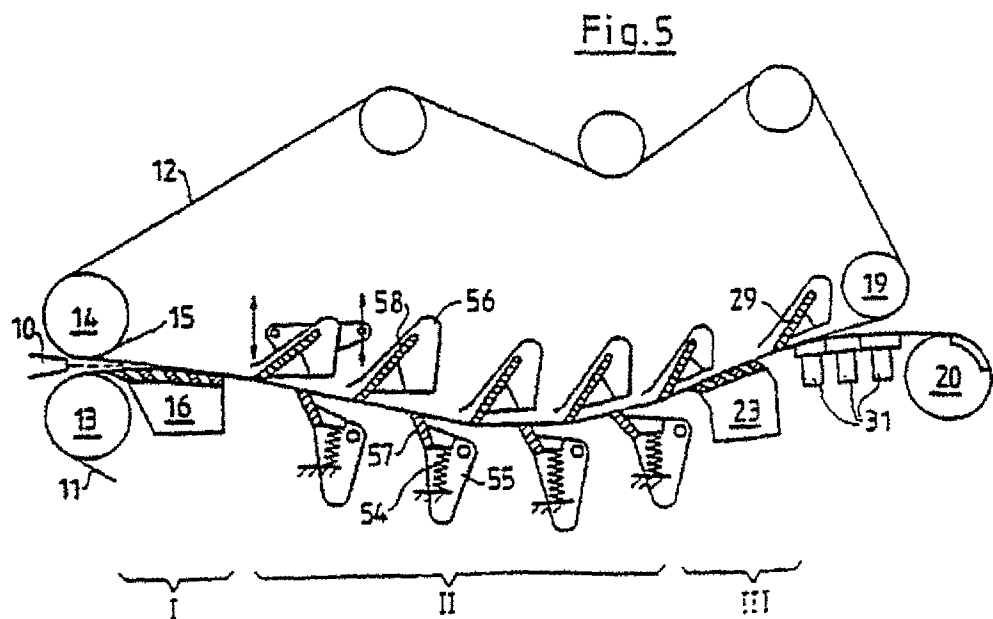
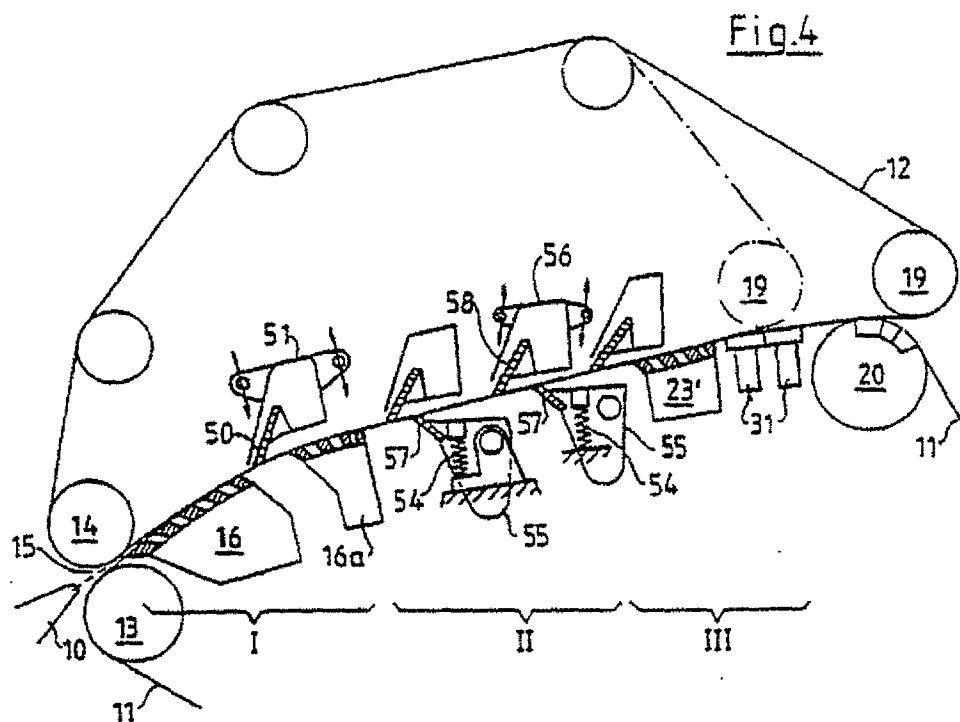


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Sheet 2 of 2

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TWIN WIRE FORMER

RELATED APPLICATIONS

This is a continuing application of, and hereby incorporates by reference the entire disclosure of, application Ser. No. 08/286,948, filed Aug. 8, 1994 now U.S. Pat. No. 5,500,091, which is a continuing application Ser. No. 08/055,918, filed Apr. 29, 1993, issued Feb. 14, 1995 as U.S. Pat. No. 5,389,206, which is a continuing application Ser. No. 07/773,965, filed as PCT/EP90/01313 Sep. 8, 1990, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to a twin-wire former for the production of a fiber web, in particular a paper web, from a fiber suspension. The invention proceeds from the basis of the twin-wire former known from British Patent 1 125 906. The features indicated in the patent include a twin wire former for producing a fiber web and particularly a paper web from a fiber suspension. Two web forming wire belts, in the form of endless loops, travel together to form a twin wire zone. The web travels between and along the path of the wire belts through the twin wire zone. The twin wire zone has three sections and the elements in those three sections are described below. The patent describes features that state, in other words, that the forming of the fiber web from the pulp suspension fed from the headbox takes place exclusively between two wire belts. Thus, there is no so-called single-wire pre-drainage path. In a first section of the twin-wire zone, the two wire belts together form a wedge-shaped inlet slot; a jet of pulp slurry coming from the headbox discharges into it. The jet strikes the two wire belts at a place where they pass over a curved drainage element; in the case of the aforementioned British patent, this is a stationary, curved forming shoe. Its curved wire guide surface is formed of a plurality of strips with drainage slots between them. This forming shoe is followed (in a second section of the twin-wire zone) by a drainage strip arranged in the other wire loop and, behind the latter, by a drainage strip arranged in the first-mentioned wire loop (and formed by a first suction box). Finally, in a third section of the twin-wire zone there are a plurality of stationary drainage elements developed as flat suction boxes.

It has been attempted for decades with twin-wire formers of the known type to produce fiber webs (in particular, paper webs) of the highest possible quality with relatively high operating speeds. Due to the forming of the web between two wires, the result, in particular, is obtained that the final fiber web has substantially the same properties on both sides (little "two-sidedness"). However, it is difficult to obtain as uniform as possible a distribution of the fibers in the final fiber web. In other words, it is difficult to obtain a good "formation" since while the web is formed, there is always the danger that fibers will agglomerate and form floculations. Therefore, it is attempted to form a jet of pulp slurry which pulp slurry is as free as possible of floculations in the headbox (for instance, by means of a turbulence producer). It is, furthermore, endeavored so to influence the drainage of the fiber suspension during the web-forming that "refloculation" is avoided as far as possible or that, after possible floculation, a "defloculation" (i.e. a breaking up of the floculations) takes place.

It is known that a curved drainage element arranged in the first section of the twin-wire zone and, in particular, a stationary curved forming shoe developed in accordance with the aforementioned British Patent 1 125 906 counter-

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acts the danger of refloculation. This is true also of the drainage strips arranged in the British patent in the second section of the twin-wire zone. Nevertheless, the danger of refloculation is not completely eliminated in the arrangement according to said British patent. Since the number of drainage strips there is very small, a large part of the web-forming takes place in the region of the following flat-suction boxes. They, to be sure, are of high drainage capacity so that the web-forming can be completed in the region of the last flat suction boxes (i.e. the so-called main drainage zone, in which a part of the fiber material is still in the form of a suspension, terminates in the region of the flat suction box). The flat suction boxes, however, are not able to avoid refloculation or to break up floculations which have already occurred.

In order to control these last-mentioned difficulties, a web-forming device known under the name of "Duoformer D" has been developed (TAPPI proceedings 1988 annual meeting, pages 75 to 80). This known web-forming device is part of a twin-wire former which has a single-wire pre-drainage zone. In the twin-wire zone there are provided, in the one wire loop, a plurality of strips which are fixed in position but adjustably supported, namely, on the bottom of a suction box which drains in upward direction. Furthermore, a plurality of resiliently supported strips are provided in the other wire loop. By this resilience of the last-mentioned strips, the following result can be obtained: For example, upon an increase of the amount of suspension entering between the two wire belts, the flexibly supported strips can move away somewhat. In this way, the danger (which is present when only firmly supported strips are used) is eliminated of a backing up taking place in the fiber suspension in front of the strips. Such a backing up could destroy the fiber layers which have been formed up to then on the two wire belts. In other words, with this known web-forming device, a drainage pressure, once established, remains constant due to the resiliently supported strips even upon a change in the amount of suspension fed or upon a change in the drainage behavior of the fiber suspension. Therefore, automatic adaptation of the web-forming device to said changed conditions occurs.

With this known web-forming device, fiber webs of relatively good formation can also be formed. With respect to this, however, the demands have increased considerably recently, so that further improvements are desirable.

SUMMARY OF THE INVENTION

The object of the invention is so to develop a twin-wire of the aforementioned kind that the quality of the fiber web produced is further improved, particularly with respect to its formation (cloudiness), and that the twin-wire former can easily be adapted to different operating conditions (for instance, with regard to quantity and drainage behavior of the fiber suspension).

This object is achieved by the features set forth below. In particular, there is a respective drainage strip above each of the two wire belts in the second section of the twin wire zone, and at least one of the two drainage strips is supported resiliently against the respective wire belt while the other may or may not be resiliently supported, and typically is rigidly supported against the respective wire belt. Preferably, there are at least two of the drainage strips and often more against each of the wire belts. The drainage strips against one belt are offset along the path of the wire belts with respect to the drainage strips against the other belt, providing a zig zag or staggered array, and the drainage strips against at least one of the belts are resiliently supported.

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The inventors have found that a combination of known features, namely:

- A. Twin-wire former without a single-wire pre-drainage zone or at least without a single-wire pre-drainage zone of any substantial length such as to cause any appreciable pre-drainage
- B. Start of the drainage in the twin-wire zone at a preferably curved drainage element, for instance on a rotating forming cylinder or, even better, on a curved stationary forming shoe
- C. Further drainage in the twin-wire zone between strips which are arranged along a "zig-zag" line, the strips which rest against the one wire belt being resiliently supported.

leads to an extremely high increase in the quality of the finished fiber web, so that it satisfies even the highest requirements. At the same time, the twin-wire former of the invention is insensitive to changes in the amount of suspension fed and to changes in the drainage behavior of the fiber suspension. Experiments have shown that it is possible by the invention to obtain both a high increase in quality with respect to the formation and also good values with regard to the retention of fillers and fines. In contradistinction to this, in the known double-wire formers it is constantly found that there is a strong reduction in the retention upon an improvement in the formation.

It was, furthermore, found in experiments that in the second section of the twin-wire zone the number of strips can be considerably reduced as compared with the "Duo-former D". However, this number is substantially greater than in the case of the twin-wire former known from British Patent 1 125 906. It is advantageous to increase the distance between adjacent strips as compared with the "Duo-former D". In particular, the drainage strips above each one of the wire belts are of a thickness along the path of the wire belts and the spacing between adjacent strips above each wire belt is a minimum of about three times the strip thickness.

To be sure, from German OS 31 38 133, FIG. 3, a twin-wire former is known the twin-wire zone of which is provided in a first section with a curved stationary drainage element and in a second section with strips arranged along a "zig-zag" line, which strips may also be resiliently supported and there being a relatively large distance between them. However, in that case, in front of the twin-wire zone there is a single-wire pre-drainage zone in which the forming of the web starts initially only in a lower layer of the fiber suspension fed while the upper layer remains liquid and tends very strongly to flocculation. It has been found that these flakes cannot be broken up again to the desired extent in the following twin-wire zone. Another disadvantage is that the twin-wire zone is diverted by a guide roll (14b) behind the second section. This results (due to the so-called table-roll effect) in a further drainage which is uneven over the width of the web and thus in undesired variations in the quality of the web (recognizable, for instance, by disturbing longitudinal stripes).

BRIEF DESCRIPTION OF THE DRAWINGS

Other developments of the invention will be explained below with reference to embodiments which are shown in the drawing. Each of FIGS. 1 to 5 shows in simplified diagrammatic form one of the different embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The twin-wire former shown in FIG. 1 has a substantially horizontally extending twin-wire zone; this zone comprises

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three sections I, II and III arranged one behind the other. The endless wire belts (lower wire 11 and upper wire 12), shown only in part, travel in the direct vicinity of a headbox 10 over, in each case, a breast roll 13 and 14 respectively, so that the two wire belts together form a wedge-shaped entry slot 15 at the start of the twin-wire zone. The jet pulp discharged by the headbox 10 comes into contact with the two wire belts 11 and 12 only at the place where the lower wire 11 in the first section I of the twin-wire zone travels over a stationary curved forming shoe 16. The curved travel surface thereof is formed of several strips 16' with drainage slits present between them. The distance between the two breast rolls 13 and 14 is variable. The forming shoe 16 can be operated with or without vacuum. Additionally, although it is preferable that the forming shoe 16 be curved, a straight forming shoe may also be used in certain situations.

In the second section II of the twin-wire zone, the two wire belts 11 and 12 (with the partially still liquid fiber suspension present between them) travel between a lower drainage box 17 and an upper drainage box 18. In the lower drainage box 17 there are a row of at least two strips 27 (preferably of approximately rectangular cross section) which are pressed from below resiliently against the lower wire 11. For this purpose, they are supported, for instance, on springs 24 (or pneumatic pressure cushions) on a, preferably water-permeable, plate. It is obvious that the force of the springs (or of the pressure prevailing in the pressure cushions) is individually adjustable.

The upper drainage box 18 is suspended on both the front and rear ends on vertically displaceable support elements as indicated diagrammatically by double arrows. On its lower side, there is a row of at least three strips 28 of preferably parallelogram cross section which rest against the upper side of the upper wire 12 and are rigidly attached to the box 18. Above the strips 28, a front vacuum chamber 21 and a rear vacuum chamber 22 are present in the drainage box 18.

Each of the upper strips 28 scrapes off water from the wire 12. Accordingly, the amount of water scraped off decreases in the direction of flow of the wire 12 from strip to strip. The drainage water from each of the strips 28 except the drainage water scraped off by the first strip may be drained away jointly. However, it is disadvantageous to also include the drainage water from the first strip 28 since this generally would disturb the operation of the other strips. Accordingly, a vertical channel 21a is positioned in front of the first upper strip 28 to carry away or collect the water scraped off by the first strip 28.

In the region of the forming shoe 16, a part of the water of the fiber suspension is led off downward; another part penetrates due to the tension of the upper wire 12 upwards through the upper wire and is deflected by the furthest in front of the strips 28 into the front vacuum chamber 21. The water passing upward between the upper strips 28 enters into the rear vacuum chamber 22. The water penetrating between the lower strips 27 through the lower wire 11 is led off downward. Between adjacent upper drainage strips 28 there is a minimum distance X of about three times the thickness Y of the strips. The same is true of the lower resiliently supported strips 27. It is important that each of the strips 27 and 28 lies in the region of a space between two opposite strips so that a "zig-zag" arrangement (i.e. non-opposing relationship) is present. Also, as seen in FIG. 1, the first one of the strips 28 is located upstream of the first one of the strips 27. The two wires 11 and 12 preferably travel on a straight path through section II. Gentle curvature of this section of the path is, however, also possible; see FIGS. 2 and 5. Differing from FIG. 1, the resiliently supported strips

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could also be arranged in the upper box 18 and the firmly supported strips in the lower box 17. In the third section III of the twin-wire zone, both wire belts 11 and 12 travel over another preferably curved forming shoe 23 which (as shown) is arranged preferably in the lower wire loop 11. Behind it, an additional strip 29 with vacuum chamber 30 can be arranged in the loop of the upper wire 12. Furthermore, flat suction boxes 31 can be present in the loop of the lower wire. There (as is shown by dash-dot lines) the upper wire 12 can be separated by means of a guide roll 19 from the lower wire 11 and from the fiber web formed. Lower wire and fiber web then travel over a wire suction roll 20. The guide roll 19 can, however, also lie further back, so that the upper wire 12 is separated from the lower wire 11 only on the wire suction roll 20.

It is important that two drainage boxes 17 and 18 with the alternately resiliently and firmly supported ledge strips 27 and 28 lie not in the front or the rear sections but in the middle section II of the twin-wire zone, since only here can they develop their full effect, namely, intensive drainage of the fiber suspension fed while retaining the fine flocculation-free fiber distribution. This is achieved in the manner that the corresponding wire belt is imparted a slight (scarcely visible) deflection on each strip so that turbulence is constantly produced in the still liquid part of the fiber pulp. For success it is, however, also decisive that previously, in section I, a known pre-drainage towards both sides has already taken place and that this also takes place with the greatest possible retention of the flocculation-free condition of the fiber suspension.

For this two-sided pre-drainage, a stationary preferably curved forming shoe is provided in the first section I of the twin-wire zone (in accordance with FIGS. 1 and 3-5) whenever it is a question of satisfying the highest quality demands with respect to the formation. This effect of the forming shoe is due to the fact that at least the one wire belt travels polygonally from strip to strip, each strip not only leading water away but also producing turbulence in the pulp which is still liquid. With such a forming shoe, it is, however, difficult at times to obtain a stable operating condition upon the starting of the paper machine. Therefore, it may be advantageous to provide a known forming roll 40 in accordance with FIG. 2 in Section I instead of the stationary forming shoe and the breast roll lying in front of it. This possibility will be utilized when, in particular, the highest productivity is demanded from the paper manufacturing machine.

In the third section III, the aforementioned strip 29 can serve either solely to lead away water upwards or, in addition, for the further production of turbulence (for further improvement in quality). The latter is possible if a part of the fiber pulp is still in liquid condition at this place.

In FIGS. 1 to 3, the distance between the two wires 11 and 12 in the twin-wire zone has been shown greatly exaggerated. By this, it is intended to make it clear that the two wires 11 and 12 converge towards each other over a relatively long path within the twin-wire zone. This makes it clear that the process of web-forming on the first forming shoe 16 (in Section I) commences relatively slowly and is completed only in Section III. In this connection, the end of the main drainage zone in which the two wires converge towards each other (and thus, the end of the web-forming process) can lie approximately in the center of the wrapping zone of the second forming shoe 23, as is indicated, merely by way of example, in FIGS. 1 to 3. The end of the wire convergence is symbolically indicated there by the point E; the solids content of the paper web has reached there approximately

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the value of 8%. This point can, however, also lie, for instance, on one of the flat suction boxes 31. Behind this point, it is attempted further to increase the solids content, if possible even before the separation of the two wires. One goal is, namely, for the separation of the wires to take place with the highest possible solids content of the web so that as few fibers as possible are torn out of the web upon the separation. The nature and number of the drainage elements necessary for this within the twin-wire zone may, however, differ greatly and is dependent, among other things, on the type of paper and the raw-material components thereof, as well as on the operating speed.

The embodiments shown in FIGS. 2 and 3 differ from the others primarily by the fact that the twin-wire zone rises substantially vertically upward in the direction of travel of the wires. In this way, the removal of the water withdrawn from the fiber suspension is simplified since the water can be discharged relatively uniformly towards both sides. No vacuum chambers are required in particular in the central section II of the twin-wire zone. To be sure, the forming roll 40 of FIG. 2 is, as a rule, developed as a suction roll. The forming shoes 16, 23, particularly those arranged in the third section III, can, if necessary, be provided with a suction device.

Further elements of the twin-wire former shown in FIG. 2 are water-collection containers 41, 42 and 43, guide plates 44 associated with the fixed strips 28, and a water removal strip 45. The other elements are provided with the same reference numbers as the corresponding elements in FIG. 1. The same is true with regard to FIG. 3. One possible modification of FIG. 3 can consist therein that, instead of the wire suction roll 20, a forming roll is provided, and instead of the guide roll 19 the wire suction roll. A similar arrangement is known from German Utility Model 88 06 036 (Voith File: P 4539). Aside from this exception and aside from the embodiment according to FIG. 2 (with forming roll 40), the invention will, however, be used whenever possible so to design the twin-wire former that the relatively expensive forming roll (as to purchase and operation) can be dispensed with. Thus, as a rule, the wire suction roll 20 is present as the sole suction roll. Furthermore, in all embodiments of the invention it can be seen to it that no guide roll which deflects the twin-wire zone (and has the above-mentioned injurious table-roll effect) is present.

The embodiment of FIG. 4 differs from FIG. 1 among other things by the fact that, in the first section I of the twin-wire zone, a second curved stationary forming shoe 16a is arranged in the loop of the lower wire 11 behind and spaced from a first curved stationary forming shoe 16. Furthermore, in the loop of the upper wire 12 in the region between the two stationary forming shoes 16 and 16a there is provided an individual strip 50 which in known manner is part of a vacuum chamber 51. This vacuum chamber 51, similar to the upper drainage box 18 of FIG. 1, is suspended on its front and rear ends in vertically displaceable mounts. In this way, both the depth of penetration of the strip 50 into the path of travel of the upper wire 12 as well as the angle of attack of the strip 50 can be varied. With slight depth of penetration, the strip 50 serves solely for removal of water, while with greater depth of penetration it serves, in addition, for the production of turbulence in the suspension and, thus, for improvement of the formation. By the presence of two separate forming shoes 16 and 16a, the pre-drainage on both sides is temporarily interrupted; it is only continued after the strip 50 has removed from the upper wire 12 the water which has penetrated upward on the first forming shoe 16. In this way, higher operating speeds are possible.

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Another difference from FIG. 1 is that, in the second section II of the twin-wire zone, the lower, flexibly supported strips 57 and the upper, firmly supported strips 58 are developed as individual strips. This means that each strip has its own supporting body 55/56. The lower strip-supporting bodies 55 are swingably mounted, the strip 57 being pressed resiliently by the force of springs 54 against the bottom of the lower wire 11. The supporting body 56 of each of the upper strips 58 is developed as vacuum chamber in the same way as that of the strip 50. The suspension of these vacuum chambers 56 corresponds to that of the vacuum chamber 51. It is important that each of the strips 57 and 58 rest with a given force of application (corresponding to the suspension pressure) against its wire belt 11 or 12. The strips 57 and 58 are adjusted in such a manner that a slight deflection of the wire belts takes place preferably on each strip. Due to the resilient supporting of the lower strips 57, the adjustment, once effected, is insensitive to changes in the quantity or quality of pulp, so that no backing up takes place in front of the strips and, nevertheless, an effective introduction of turbulence forces into the fiber suspension takes place. In contradistinction to FIGS. 1 to 3, there is the possibility of adjusting each one of the strips 57/58 individually with respect to position in height and inclination relative to the travel path of the wire. In this way, one can even better control the quality of the paper produced, with respect to both the formation and the nature of its surface (printability). Differing from FIG. 4, the upper strips 58 could be supported resiliently and the lower strips 57 stationary. Another alternative could consist therein that not only the upper strips 58 but also the lower strips 57 are fastened in vertically displaceable mounts (as shown on the vacuum chamber 51). In such case, the springs 54 might possibly be eliminated.

Another difference between FIGS. 1 and 4 resides in the fact that in FIG. 4 the twin-wire zone rises in the direction of travel of the wires upwards with an inclination of, on the average, about 20° with respect to the horizontal. In this way, it is possible to keep the entire height of the twin-wire former relatively slight. In the third section III of the twin-wire zone, a flat forming shoe 23' is provided rather than a curved one, differing from FIG. 1. The separation of the upper wire 12 from the lower wire and the fiber web formed can take place, as in FIG. 1, on one of the flat suction boxes 31. Instead of this, however, the upper wire 12 can also be conducted up to the wire suction roll 20. There, as shown, it can wrap around a small part (or, alternatively, a larger part) of the circumference of the wire suction roll and then be returned via the reversing roll 19.

In the embodiment shown in FIG. 5, the twin-wire zone, as a whole, extends substantially in horizontal direction. The individual elements are substantially the same as in the embodiment of FIG. 4. However, there is the difference that the drainage strips 57 and 58 lying in the second section II of the twin-wire zone are arranged along a downwardly curved path of the twin-wire zone. Accordingly, an upwardly curved forming shoe 16, 23 is provided in the first section I and in the third section III of the twin-wire zone. This embodiment is advisable, in particular, for the modernizing of existing Fourdrinier paper machines.

The embodiments shown have the feature in common that, in the second section II of the twin-wire zone, there are present preferably n flexibly supported strips 27/57 and $n+1$ rigidly supported strips. However, it is also possible to make the number of flexibly supported strips equal to or greater by one than the number of rigidly supported strips. Instead of a rigidly supported strip, a feed or discharge edge of a drainage box can also be provided. The minimum number n

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of flexibly supported strips is two (see FIG. 4). However, three or four flexibly supported strips are preferred.

What is claimed is:

1. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:
 - first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;
 - each wire belt forming an endless loop;
 - the twin wire zone having a first section which includes a first drainage element at the start of the path through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone;
 - the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone in the second section, a plurality of first drainage strips are positioned for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that the strips contact;
 - second support means supporting the second drainage strips rigidly against the second wire belt;
 - first means for collecting the water drained from the fiber suspension by the most upstream, one of the drainage strips;
 - second means separate from the first means for collecting the water drained from the fiber suspension by all of the other drainage strips; and
 - the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a second drainage element in the third section for being engaged by one of the wire belts as the wire belts travel over the second drainage element, the twin wire zone being free of rolls which deflect the twin wire zone.
2. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:
 - first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;
 - each wire belt forming an endless loop;
 - the twin wire zone having a first section which includes a first drainage element at the start of the path through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber sus-

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pension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone; the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone; in the second section, a plurality of first drainage strips are positioned for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that the strips contact;

second support means supporting the second drainage strips rigidly against the second wire belt; first means for collecting the water drained from the fiber suspension by the most upstream one of the drainage strips;

second means separate from the first means for collecting the water drained from the fiber suspension by all of the other drainage strips; and

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone: a second drainage element in the third section for being engaged by one of the wire belts as the wire belts travel over the second drainage element, the twin wire zone being free of any forming rolls.

3. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section which includes a first drainage element at the start of the path through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone;

the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone; in the second section, a plurality of first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that the strips contact, the last one of the second drainage strips being located downstream of the last one of the first drainage strips;

second support means supporting the second drainage strips rigidly against the second wire belt;

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the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a second drainage element in the third section for being engaged by one of the wire belts as the wire belts travel over the second drainage element, the second drainage element having an open surface to enable water to be drained through the wire belt in contact therewith; and

the twin wire zone being free of rolls which deflect the twin wire zone.

4. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section which includes a first drainage element at the start of the path through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone;

the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone; in the second section, a plurality of first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that the strips contact, the last one of the second drainage strips being located downstream of the last one of the first drainage strips;

second support means supporting the second drainage strips rigidly against the second wire belt;

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a second drainage element in the third section for being engaged by one of the wire belts as the wire belts travel over the second drainage element; and

the twin wire zone being free of any forming rolls.

5. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section which includes a single first drainage element at the start of the path

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through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone; said single first drainage element in the first section being a single forming roll having an open surface to enable drainage of water from the fiber suspension and being curved along the path of the belts through the twin wire zone, the single forming roll being engaged by one of the wire belts for curving the path of the belts around the single forming roll after the entrance of the suspension into the entrance slot;

the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone; in the second section, a plurality of first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts

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with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that the strips contact;

second support means supporting the second drainage strips rigidly against the second wire belt; and

means for supplying a vacuum in the area of the second drainage strips;

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a second drainage element in the third section, for being engaged by one of the wire belts as the wire belts travel over the second drainage element, the second drainage element having an open surface to enable water to be drained through the wire belt in contact therewith; and

the twin wire zone apart from said single forming roll being free of rolls which deflect the twin wire zone.

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Exhibit 3



US005853544A

United States Patent [19]
Egelhof et al.

[11] Patent Number: 5,853,544
[45] Date of Patent: Dec. 29, 1998

[54] TWIN WIRE FORMER

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Related U.S. Application Data

[63] Continuation of Ser. No. 556,769, Nov. 2, 1995, Pat. No. 5,718,805, which is a continuation of Ser. No. 286,948, Aug. 8, 1994, Pat. No. 5,508,091, which is a continuation of Ser. No. 55,918, Apr. 29, 1993, Pat. No. 5,389,206, which is a continuation of Ser. No. 773,965, Nov. 12, 1991, abandoned.

[30] Foreign Application Priority Data

Aug. 22, 1989 [DE] Germany 39 27 597.3

[51] Int. Cl.⁶ D21F 1/00

[52] U.S. Cl. 162/203; 162/301

[53] Field of Search 162/203, 303, 162/301, 303, 348, 352

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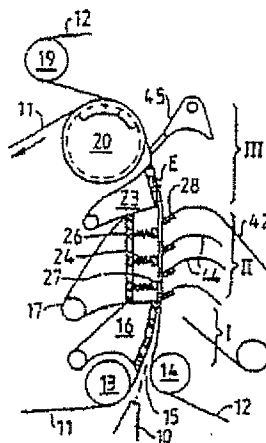
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[57] ABSTRACT

In a twin-wire former for the production of a paper web, two wire belts (11 and 12) together form a twin-wire zone which is divided into three sections (I, II and III). In the first section (I) the two wires (11, 12) travel over a curved forming shoe (16). They form there a wedge-shaped inlet slot (15) with which a headbox (10) is directly associated. In the second section (II), several resiliently supported strips (27) rest against the lower wire (11) and between each of said strips (27) a rigidly mounted strip (28) rests against the upper wire (12). In the third section (III) both wire belts (11, 12) pass over another curved forming shoe (23).

2 Claims, 2 Drawing Sheets



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Fig.1

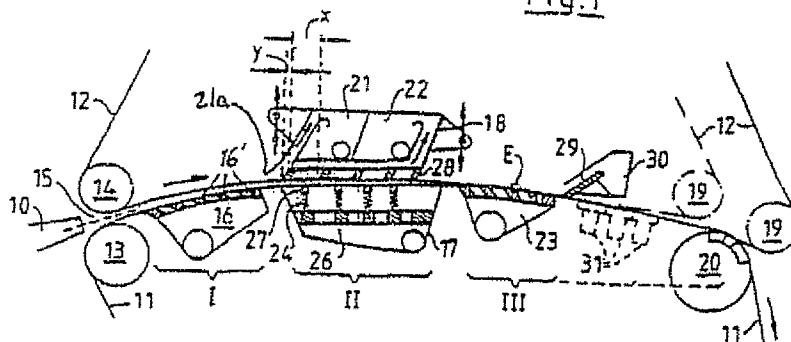


Fig.2

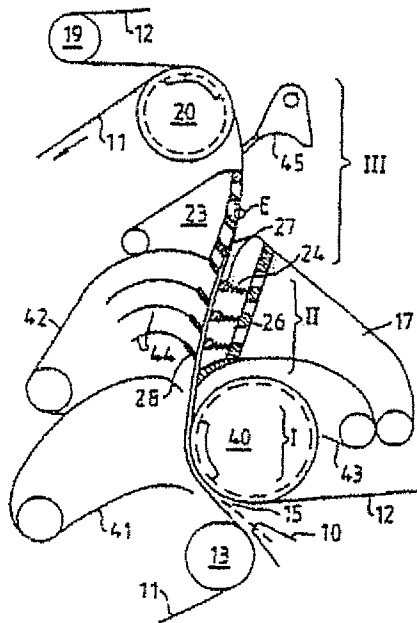
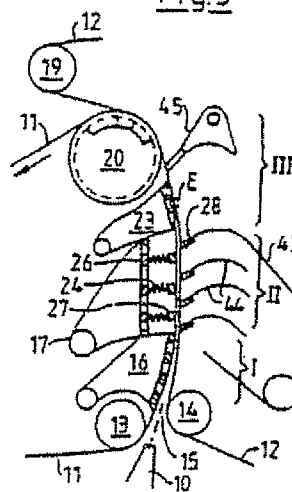


Fig.3

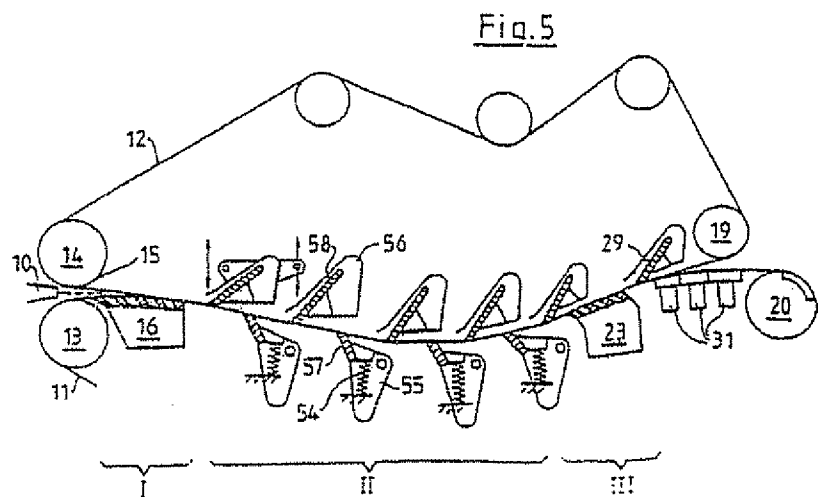
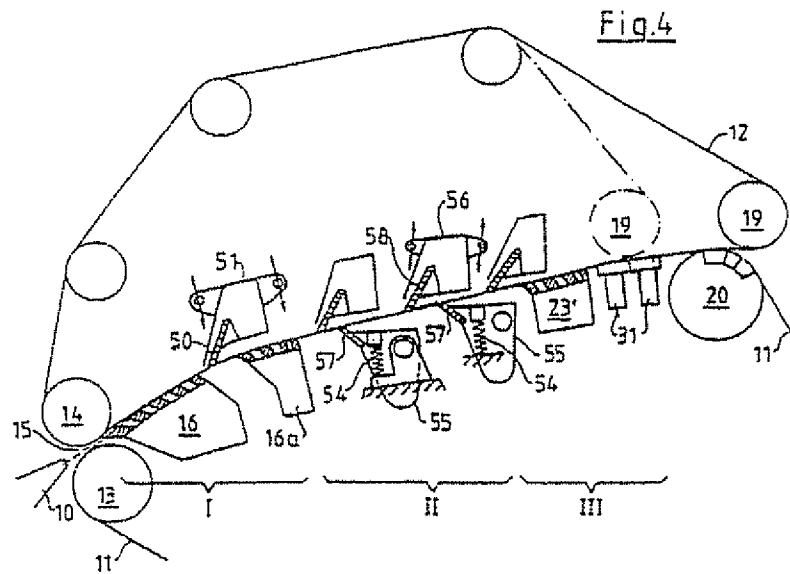


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TWIN WIRE FORMER
RELATED APPLICATIONS

This is a continuing application of, and hereby incorporates by reference the entire disclosure of, application Ser. No. 08/556,769, filed Nov. 2, 1995 now U.S. Pat. No. 5,718,805, which is a continuing application Ser. No. 08/286,948, filed Aug. 6, 1994 now U.S. Pat. No. 5,500,091, which is a continuing application Ser. No. 08/055,918, filed Apr. 29, 1993, issued Feb. 14, 1995 as U.S. Pat. No. 5,389,206, which is a continuing application Ser. No. 07/773,965, filed Nov. 12, 1991, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to a twin-wire former for the production of a fiber web, in particular a paper web, from a fiber suspension. The invention proceeds from the basis of the twin-wire former known from British Patent 1 125 906. The features indicated in the patent include a twin wire former for producing a fiber web and particularly a paper web from a fiber suspension. Two web forming wire belts, in the form of endless loops, travel together to form a twin wire zone. The web travels between and along the path of the wire belts through the twin wire zone. The twin wire zone has three sections and the elements in those three sections are described below. The patent describes features that state, in other words, that the forming of the fiber web from the pulp suspension fed from the headbox takes place exclusively between two wire belts. Thus, there is no so-called single-wire pre-drainage path. In a first section of the twin-wire zone, the two wire belts together form a wedge-shaped inlet slot; a jet of pulp slurry coming from the headbox discharges into it. The jet strikes the two wire belts at a place where they pass over a curved drainage element; in the case of the aforementioned British patent, this is a stationary, curved forming shoe. Its curved wire guide surface is formed of a plurality of strips with drainage slots between them. This forming shoe is followed (in a second section of the twin-wire zone) by a drainage strip arranged in the other wire loop and, behind the latter, by a drainage strip arranged in the first-mentioned wire loop (and formed by a first suction box). Finally, in a third section of the twin-wire zone there are a plurality of stationary drainage elements developed as flat suction boxes.

It has been attempted for decades with twin-wire formers of the known type to produce fiber webs (in particular, paper webs) of the highest possible quality with relatively high operating speeds. Due to the forming of the web between two wires, the result, in particular, is obtained that the final fiber web has substantially the same properties on both sides (little "two-sidedness"). However, it is difficult to obtain as uniform as possible a distribution of the fibers in the final fiber web. In other words, it is difficult to obtain a good "formation" since while the web is formed, there is always the danger that fibers will agglomerate and form flocculations. Therefore, it is attempted to form a jet of pulp slurry which pulp slurry is as free as possible of flocculations in the headbox (for instance, by means of a turbulence producer). It is, furthermore, endeavored so to influence the drainage of the fiber suspension during the web-forming that "reflocculation" is avoided as far as possible or that, after possible flocculation, a "deflocculation" (i.e. a breaking up of the flocculations) takes place.

It is known that a curved drainage element arranged in the first section of the twin-wire zone and, in particular, a stationary curved forming shoe developed in accordance

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with the aforementioned British Patent 1 125 906 counteracts the danger of reflocculation. This is true also of the drainage strips arranged in the British Patent in the second section of the twin-wire zone. Nevertheless, the danger of reflocculation is not completely eliminated in the arrangement according to said British Patent. Since the number of drainage strips there is very small, a large part of the web-forming takes place in the region of the following flat-suction boxes. They, to be sure, are of high drainage capacity so that the web-forming can be completed in the region of the last flat suction boxes (i.e. the so-called main drainage zone, in which a part of the fiber material is still in the form of a suspension, terminates in the region of the flat suction box). The flat suction boxes, however, are not able to avoid reflocculation or to break up flocculations which have already occurred.

In order to control these last-mentioned difficulties, a web-forming device known under the name of "Duoformer D" has been developed (TAPPI Proceedings 1988 annual meeting, pages 75 to 80). This known web-forming device is part of a twin-wire former which has a single-wire pre-drainage zone. In the twin-wire zone there are provided, in the one wire loop, a plurality of strips which are fixed in position but adjustably supported, namely, on the bottom of a suction box which drains in upward direction. Furthermore, a plurality of resiliently supported strips are provided in the other wire loop. By this resilience of the last-mentioned strips, the following result can be obtained: For example, upon an increase of the amount of suspension entering between the two wire belts, the flexibly supported strips can move away somewhat. In this way, the danger (which is present when only firmly supported strips are used) is eliminated of a backing up taking place in the fiber suspension in front of the strips. Such a backing up could destroy the fiber layers which have been formed up to then on the two wire belts. In other words, with this known web-forming device, a drainage pressure, once established, remains constant due to the resiliently supported strips even upon a change in the amount of suspension fed or upon a change in the drainage behavior of the fiber suspension. Therefore, automatic adaptation of the web-forming device to said changed conditions occurs.

With this known web-forming device, fiber webs of relatively good formation can also be formed. With respect to this, however, the demands have increased considerably recently, so that further improvements are desirable.

SUMMARY OF THE INVENTION

The object of the invention is so to develop a twin-wire of the aforementioned kind that the quality of the fiber web produced is further improved, particularly with respect to its formation (cloudiness), and that the twin-wire former can easily be adapted to different operating conditions (for instance, with regard to quantity and drainage behavior of the fiber suspension).

This object is achieved by the features set forth below. In particular, there is a respective drainage strip above each of the two wire belts in the second section of the twin wire zone, and at least one of the two drainage strips is supported resiliently against the respective wire belt while the other may or may not be resiliently supported, and typically is rigidly supported against the respective wire belt. Preferably, there are at least two of the drainage strips and often more against each of the wire belts. The drainage strips against one belt are offset along the path of the wire belts with respect to the drainage strips against the other belt, providing

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a zig zag or staggered array, and the drainage strips against at least one of the belts are resiliently supported.

The inventors have found that a combination of known features, namely:

A. Twin-wire former without a single-wire pre-drainage zone or at least without a single-wire pre-drainage zone of any substantial length such as to cause any appreciable pre-drainage

B. Start of the drainage in the twin-wire zone at a preferably curved drainage element, for instance on a rotating forming cylinder or, even better, on a curved stationary forming shoe

C. Further drainage in the twin-wire zone between strips which are arranged along a "zig-zag" line, the strips which rest against the one wire belt being resiliently supported,

leads to an extremely high increase in the quality of the finished fiber web, so that it satisfies even the highest requirements. At the same time, the twin-wire former of the invention is insensitive to changes in the amount of suspension fed and to changes in the drainage behavior of the fiber suspension. Experiments have shown that it is possible by the invention to obtain both a high increase in quality with respect to the formation and also good values with regard to the retention of fillers and fines. In contradistinction to this, in the known double-wire formers it is constantly found that there is a strong reduction in the retention upon an improvement in the formation.

It was, furthermore, found in experiments that in the second section of the twin-wire zone the number of strips can be considerably reduced as compared with the "Duo-former D". However, this number is substantially greater than in the case of the twin-wire former known from British Patent 1 125 906. It is advantageous to increase the distance between adjacent strips as compared with the "Duo-former D". In particular, the drainage strips above each one of the wire belts are of a thickness along the path of the wire belts and the spacing between adjacent strips above each wire belt is a minimum of about three times the strip thickness.

To be sure, from German OS 31 38 133, FIG. 3, a twin-wire former is known the twin-wire zone of which is provided in a first section with a curved stationary drainage element and in a second section with strips arranged along a "zig-zag" line, which strips may also be resiliently supported and there being a relatively large distance between them. However, in that case, in front of the twin-wire zone there is a single-wire pre-drainage zone in which the forming of the web starts initially only in a lower layer of the fiber suspension fed while the upper layer remains liquid and tends very strongly to flocculation. It has been found that these flakes cannot be broken up again to the desired extent in the following twin-wire zone. Another disadvantage is that the twin-wire zone is diverted by a guide roll (14b) behind the second section. This results (due to the so-called table-roll effect) in a further drainage which is uneven over the width of the web and thus in undesired variations in the quality of the web (recognizable, for instance, by disturbing longitudinal stripes).

BRIEF DESCRIPTION OF THE DRAWINGS

Other developments of the invention will be explained below with reference to embodiments which are shown in the drawing. Each of FIGS. 1 to 5 shows in simplified diagrammatic form one of the different embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The twin-wire former shown in FIG. 1 has a substantially horizontally extending twin-wire zone; this zone comprises

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three sections I, II and III arranged one behind the other. The endless wire belts (lower wire 11 and upper wire 12), shown only in part, travel in the direct vicinity of a headbox 10 over, in each case, a breast roll 13 and 14 respectively, so that the two wire belts together form a wedge-shaped entry slot 15 at the start of the twin-wire zone. The jet pulp discharged by the headbox 10 comes into contact with the two wire belts 11 and 12 only at the place where the lower wire 11 in the first section I of the twin-wire zone travels over a stationary curved forming shoe 16. The curved travel surface thereof is formed of several strips 16' with drainage slots present between them. The distance between the two breast rolls 13 and 14 is variable. The forming shoe 16 can be operated with or without vacuum. Additionally, although it is preferable that the forming shoe 16 be curved, a straight forming shoe may also be used in certain situations.

In the second section II of the twin-wire zone, the two wire belts 11 and 12 (with the partially still liquid fiber suspension present between them) travel between a lower drainage box 17 and an upper drainage box 18. In the lower drainage box 17 there are a row of at least two strips 27 (preferably of approximately rectangular cross section) which are pressed from below resiliently against the lower wire 11. For this purpose, they are supported, for instance, on springs 24 (or pneumatic pressure cushions) on a, preferably water-permeable, plate. It is obvious that the force of the springs (or of the pressure prevailing in the pressure cushions) is individually adjustable.

The upper drainage box 18 is suspended on both the front and rear ends on vertically displaceable support elements as indicated diagrammatically by double arrows. On its lower side, there is a row of at least three strips 28 of preferably parallelogram cross section which rest against the upper side of the upper wire 12 and are rigidly attached to the box 18. Above the strips 28, a front vacuum chamber 21 and a rear vacuum chamber 22 are present in the drainage box 18.

Each of the upper strips 28 scrapes off water from the wire 12. Accordingly, the amount of water scraped off decreases in the direction of flow of the wire 12 from strip to strip. The drainage water from each of the strips 28 except the drainage water scraped off by the first strip may be drained away jointly. However, it is disadvantageous to also include the drainage water from the first strip 28 since this greatly would disturb the operation of the other strips. Accordingly, a vertical channel 21a is positioned in front of the first upper strip 28 to carry away or collect the water scraped off by the first strip 28.

In the region of the forming shoe 16, a part of the water of the fiber suspension is led off downward; another part penetrates due to the tension of the upper wire 12 upwards through the upper wire and is deflected by the furthest in front of the strips 28 into the front vacuum chamber 21. The water passing upward between the upper strips 28 enters into the rear vacuum chamber 22. The water penetrating between the lower strips 27 through the lower wire 11 is led off downward. Between adjacent upper drainage strips 28 there is a minimum distance X of about three times the thickness Y of the strips. The same is true of the lower resiliently supported strips 27. It is important that each of the strips 27 and 28 lies in the region of a space between two opposite strips so that a "zig-zag" arrangement (i.e. non-opposing relationship) is present. Also, as seen in FIG. 1, the first one of the strips 28 is located upstream of the first one of the strips 27. The two wires 11 and 12 preferably travel on a straight path through section II. Gentle curvature of this section of the path is, however, also possible; see FIGS. 2 and 5. Differing from FIG. 1, the resiliently supported strips

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could also be arranged in the upper box 18 and the firmly supported strips in the lower box 17. In the third section III of the twin-wire zone, both wire belts 11 and 12 travel over another preferably curved forming shoe 23 which (as shown) is arranged preferably in the lower wire loop 11. Behind it, an additional strip 29 with vacuum chamber 30 can be arranged in the loop of the upper wire 12. Furthermore, flat suction boxes 31 can be present in the loop of the lower wire. There (as is shown by dash-dot lines) the upper wire 12 can be separated by means of a guide roll 19 from the lower wire 11 and from the fiber web formed. Lower wire and fiber web then travel over a wire suction roll 20. The guide roll 19 can, however, also lie further back, so that the upper wire 12 is separated from the lower wire 11 only on the wire suction roll 20.

It is important that two drainage boxes 17 and 18 with the alternately resiliently and firmly supported ledge strips 27 and 28 lie not in the front or the rear sections but in the middle section II of the twin-wire zone, since only here can they develop their full effect, namely, intensive drainage of the fiber suspension fed while retaining the fine flocculation-free fiber distribution. This is achieved in the manner that the corresponding wire belt is imparted a slight (scarcely visible) deflection on each strip so that turbulence is constantly produced in the still liquid part of the fiber pulp. For success it is, however, also decisive that previously, in section I, a known pre-drainage towards both sides has already taken place and that this also takes place with the greatest possible retention of the flocculation-free condition of the fiber suspension.

For this two-sided pre-drainage, a stationary preferably curved forming shoe is provided in the first section I of the twin-wire zone (in accordance with FIGS. 1 and 3-5) whenever it is a question of satisfying the highest quality demands with respect to the formation. This effect of the forming shoe is due to the fact that at least the one wire belt travels polygonally from strip to strip, each strip not only leading water away but also producing turbulence in the pulp which is still liquid. With such a forming shoe, it is, however, difficult at times to obtain a stable operating condition upon the starting of the paper machine. Therefore, it may be advantageous to provide a known forming roll 40 in accordance with FIG. 2 in Section I instead of the stationary forming shoe and the breast roll lying in front of it. This possibility will be utilized when, in particular, the highest productivity is demanded from the paper manufacturing machine.

In the third section III, the aforementioned strip 29 can serve either solely to lead away water upwards or, in addition, for the further production of turbulence (for further improvement in quality). The latter is possible if a part of the fiber pulp is still in liquid condition at this place.

In FIGS. 1 to 3, the distance between the two wires 11 and 12 in the twin-wire zone has been shown greatly exaggerated. By this, it is intended to make it clear that the two wires 11 and 12 converge towards each other over a relatively long path within the twin-wire zone. This makes it clear that the process of web-forming on the first forming shoe 16 (in Section I) commences relatively slowly and is completed only in Section III. In this connection, the end of the main drainage zone in which the two wires converge towards each other (and thus, the end of the web-forming process) can lie approximately in the center of the wrapping zone of the second forming shoe 23, as is indicated, merely by way of example, in FIGS. 1 to 3. The end of the wire convergence is symbolically indicated there by the point 15; the solids content of the paper web has reached there approximately

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the value of 8%. This point can, however, also lie, for instance, on one of the flat suction boxes 31. Behind this point, it is attempted further to increase the solids content, if possible before the separation of the two wires. One goal is, namely, for the separation of the wires to take place with the highest possible solids content of the web so that as few fibers as possible are torn out of the web upon the separation. The nature and number of the drainage elements necessary for this within the twin-wire zone may, however, differ greatly and is dependent, among other things, on the type of paper and the raw-material components thereof, as well as on the operating speed.

The embodiments shown in FIGS. 2 and 3 differ from the others primarily by the fact that the twin-wire zone rises substantially vertically upward in the direction of travel of the wires. In this way, the removal of the water withdrawn from the fiber suspension is simplified since the water can be discharged relatively uniformly towards both sides. No vacuum chambers are required in particular in the central section II of the twin-wire zone. To be sure, the forming roll 40 of FIG. 2 is, as a rule, developed as a suction roll. The forming shoes 16, 23, particularly those arranged in the third section III, can, if necessary, be provided with a suction device.

Further elements of the twin-wire former shown in FIG. 2 are water-collection containers 41, 42 and 43, guide plates 44 associated with the fixed strips 28, and a water removal strip 45. The other elements are provided with the same reference numbers as the corresponding elements in FIG. 1. The same is true with regard to FIG. 3. One possible modification of FIG. 3 can consist therein that, instead of the wire suction roll 20, a forming roll is provided, and instead of the guide roll 19 the wire suction roll. A similar arrangement is known from German Utility Model 88 06 036 (Volth File: P 4539). Aside from this exception and aside from the embodiment according to FIG. 2 (with forming roll 40), the invention will, however, be used whenever possible so to design the twin-wire former that the relatively expensive forming roll (as to purchase and operation) can be dispensed with. Thus, as a rule, the wire suction roll 20 is present as the sole suction roll. Furthermore, in all embodiments of the invention it can be seen to it that no guide roll which deflects the twin-wire zone (and has the above-mentioned injurious table-roll effect) is present.

The embodiment of FIG. 4 differs from FIG. 1 among other things by the fact that, in the first section I of the twin-wire zone, a second curved stationary forming shoe 16a is arranged in the loop of the lower wire 11 behind and spaced from a first curved stationary forming shoe 16. Furthermore, in the loop of the upper wire 12 in the region between the two stationary forming shoes 16 and 16a there is provided an individual strip 50 which in known manner is part of a vacuum chamber 51. This vacuum chamber 51, similar to the upper drainage box 18 of FIG. 1, is suspended on its front and rear ends in vertically displaceable mounts. In this way, both the depth of penetration of the strip 50 into the path of travel of the upper wire 12 as well as the angle of attack of the strip 50 can be varied. With slight depth of penetration, the strip 50 serves solely for removal of water, while with greater depth of penetration it serves, in addition, for the production of turbulence in the suspension and, thus, for improvement of the formation. By the presence of two separate forming shoes 16 and 16a, the pre-drainage on both sides is temporarily interrupted; it is only continued after the strip 50 has removed from the upper wire 12 the water which has penetrated upward on the first forming shoe 16. In this way, higher operating speeds are possible.

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Another difference from FIG. 1 is that, in the second section II of the twin-wire zone, the lower, flexibly supported strips 57 and the upper, firmly supported strips 58 are developed as individual strips. This means that each strip has its own supporting body 55/56. The lower strip-supporting bodies 55 are swingably mounted, the strip 57 being pressed resiliently by the force of springs 54 against the bottom of the lower wire 11. The supporting body 56 of each of the upper strips 58 is developed as vacuum chamber in the same way as that of the strip 50. The suspension of these vacuum chambers 56 corresponds to that of the vacuum chamber 51. It is important that each of the strips 57 and 58 rest with a given force of application (corresponding to the suspension pressure) against its wire belt 11 or 12. The strips 57 and 58 are adjusted in such a manner that a slight deflection of the wire belts takes place preferably on each strip. Due to the resilient supporting of the lower strips 57, the adjustment, once effected, is insensitive to changes in the quantity or quality of pulp, so that no backing up takes place in front of the strips and, nevertheless, an effective introduction of turbulence forces into the fiber suspension takes place. In contradistinction to FIGS. 1 to 3, there is the possibility of adjusting each one of the strips 57/58 individually with respect to position in height and inclination relative to the travel path of the wire. In this way, one can even better control the quality of the paper produced, with respect to both the formation and the nature of its surface (printability). Differing from FIG. 4, the upper strips 58 could be supported resiliently and the lower strips 57 stationary. Another alternative could consist therein that not only the upper strips 58 but also the lower strips 57 are fastened in vertically displaceable mounts (as shown on the vacuum chamber 51). In such case, the springs 54 might possibly be eliminated.

Another difference between FIGS. 1 and 4 resides in the fact that in FIG. 4 the twin-wire zone rises in the direction of travel of the wires upwards with an inclination of, on the average, about 20° with respect to the horizontal. In this way, it is possible to keep the entire height of the twin-wire former relatively slight. In the third section III of the twin-wire zone, a flat forming shoe 23' is provided rather than a curved one, differing from FIG. 1. The separation of the upper wire 12 from the lower wire and the fiber web formed can take place, as in FIG. 1, on one of the flat suction boxes 31. Instead of this, however, the upper wire 12 can also be conducted up to the wire suction roll 20. There, as shown, it can wrap around a small part (or, alternatively, a larger part) of the circumference of the wire suction roll and then be returned via the reversing roll 19.

In the embodiment shown in FIG. 5, the twin-wire zone, as a whole, extends substantially in horizontal direction. The individual elements are substantially the same as in the embodiment of FIG. 4. However, there is the difference that the drainage strips 57 and 58 lying in the second section II of the twin-wire zone are arranged along a downwardly curved path of the twin-wire zone. Accordingly, an upwardly curved forming shoe 16, 23 is provided in the first section I and in the third section III of the twin-wire zone. This embodiment is advisable, in particular, for the modernizing of existing fourdrinier paper machines.

The embodiments shown have the feature in common that, in the second section II of the twin-wire zone, there are present preferably a flexibly supported strips 27/57 and n+1 rigidly supported strips. However, it is also possible to make the number of flexibly supported strips equal to or greater by one than the number of rigidly supported strips. Instead of a rigidly supported strip, a feed or discharge edge of a drainage box can also be provided. The minimum number n

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of flexibly supported strips is two (see FIG. 4). However, three or four flexibly supported strips are preferred.

What is claimed is:

1. A method for the production of a paper web from a fiber suspension in a twin wire former comprising:

causing first and second web forming wire belts to travel along a path together to form a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, each wire belt forming an endless loop; feeding the wire belts across a single forming roll at the start of the path through the twin wire zone; supporting the wire belts such as to form a wedge shaped entrance slot into the twin wire zone;

supplying a fiber suspension from a headbox directly to the wedge shaped entrance slot of the twin wire zone; draining water from the fiber suspension by means of the forming roll in order to form the web from the fiber suspension;

feeding the wire belts with the fiber suspension and the web being generated therebetween downstream of the forming roll between a plurality of first drainage strips, which are positioned within the loop of the first wire belt for contacting the first wire belt, and a plurality of second drainage strips, which are positioned within the loop of the second wire belt for contacting the second wire belt, the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship;

resiliently supporting the first drainage strips against the first wire belt that the strips contact;

rigidly supporting the second drainage strips against the second wire belt;

supplying a vacuum in the area of the second drainage strips;

feeding the wire belts with the web therebetween downstream of said drainage strips across a stationary drainage element in the twin wire zone such that as the wire belts travel over the stationary drainage element, water is drained through the wire belt in contact with said stationary drainage element; and

maintaining the twin wire zone apart from said single forming roll free of rolls which would deflect the twin wire zone.

2. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts which travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section which includes a single forming roll at the start of the path of the belts through the twin wire zone; supports which support the wire belts for forming a wedge shaped entrance slot into the first section;

a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone;

said single forming roll having an open surface to enable drainage of water from the fiber suspension and being

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curved along the path of the wire belts through the twin wire zone, the single forming roll being engaged by one of the wire belts and being arranged for curving the path of both wire belts around the single forming roll after the entrance of the suspension into the entrance slot;

the twin wire zone having a second section following the first section along the path of the wire belts through the twin wire zone; in the second section, a plurality of the first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; a first strip support which resiliently sup-

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ports the first drainage strips against the first wire belt that the first strips contact;

a second strip support which supports the second drainage strips rigidly against the second wire belt; and a supplier of vacuum in the area of the second drainage strips;

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a second drainage element in the third section, for being engaged by one of the wire belts as the wire belts travel over the second drainage element, the second drainage element having an open surface to enable water to be drained through the wire belt in contact therewith; and

the twin wire zone apart from said single forming roll being free of rolls which deflect the twin wire zone.

* * * * *

Exhibit 4



US005500091A

United States Patent

[19]

[11] **Patent Number:** 5,500,091**Bück et al.**[45] **Date of Patent:** *Mar. 19, 1996**[54] TWIN-WIRE FORMER****FOREIGN PATENT DOCUMENTS**

[75] Inventors: Rudolf Bück; Dieter Egelhof; Klaus Hensler, all of Heidenheim, Germany; Werner Kade, Necnah, Wis.; Albrecht Meinecke, Heidenheim, Germany; Wilhelm Wanke, Heidenheim, Germany; Hans-Jürgen Wulz, Heidenheim, Germany

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[73] Assignee: J. M. Voith GmbH, Germany

[*] Notice: The portion of the term of this patent shall not extend beyond the expiration date of Pat. No. 5,389,206.

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[21] Appl. No.: 286,948

[22] Filed: Aug. 8, 1994

Tappi Press, "1989 Twin-Wire Seminar", Washington Hilton, Washington, D.C., Apr. 12-14, 1989, pp. iii, 103-114.

Related U.S. Application Data

[63] Continuation of Ser. No. 55,918, Apr. 29, 1993, Pat. No. 5,389,206, which is a continuation of Ser. No. 773,965, Nov. 12, 1991, abandoned.

Primary Examiner—Karen M. Hastings

Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[30] Foreign Application Priority Data

Aug. 22, 1989 [DE] Germany 39 27 597.3

[51] Int. CL⁶ D21F 1/00

[52] U.S. Cl. 162/301; 162/300

[58] Field of Search 162/203, 300, 162/301, 303, 348, 352

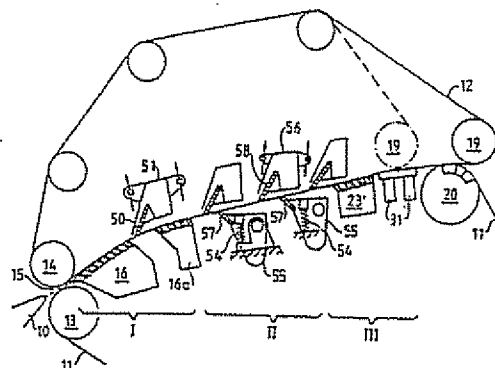
[57] ABSTRACT

In a twin-wire former for the production of a paper web, two wire belts (11 and 12) together form a twin-wire zone which is divided into three sections (I, II and III). In the first section (I) the two wires (11, 12) travel over a curved forming shoe (16). They form there a wedge-shaped inlet slot (15) with which a headbox (10) is directly associated. In the second section (II), several resiliently supported strips (27) rest against the lower wire (11) and between each of said strips (27) a rigidly mounted strip (28) rests against the upper wire (12). In the third section (III) both wire belts (11, 12) pass over another curved forming shoe (23).

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2 Claims, 2 Drawing Sheets



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Fig.1

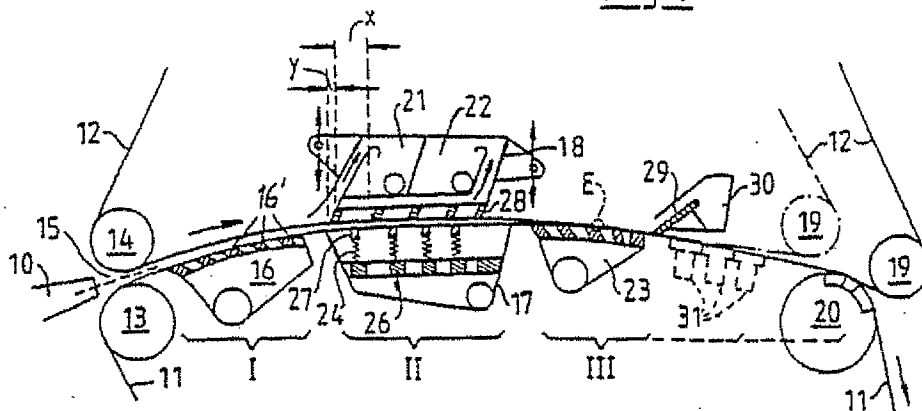


Fig.2

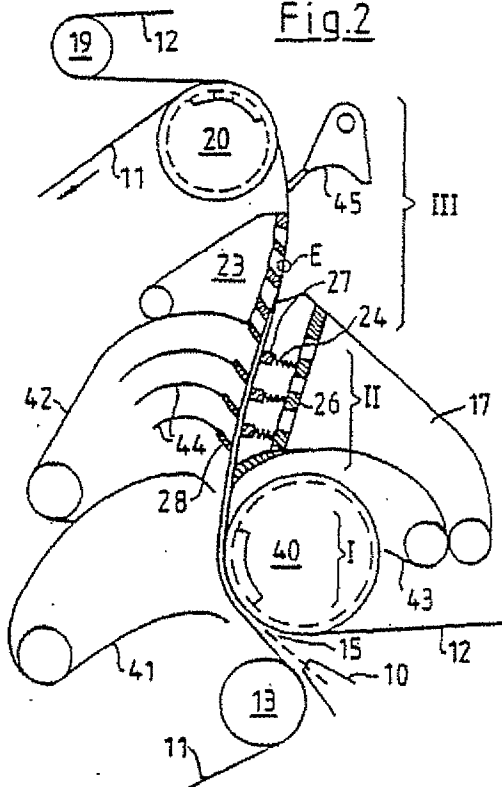
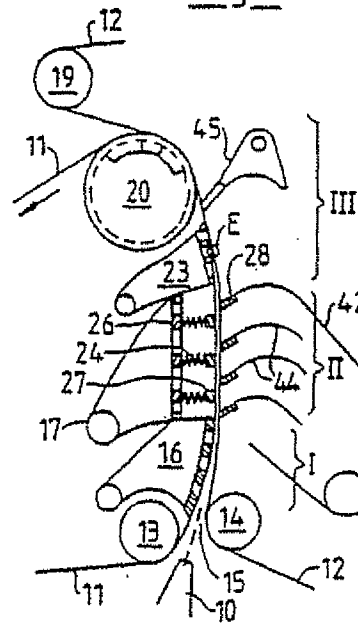


Fig.3

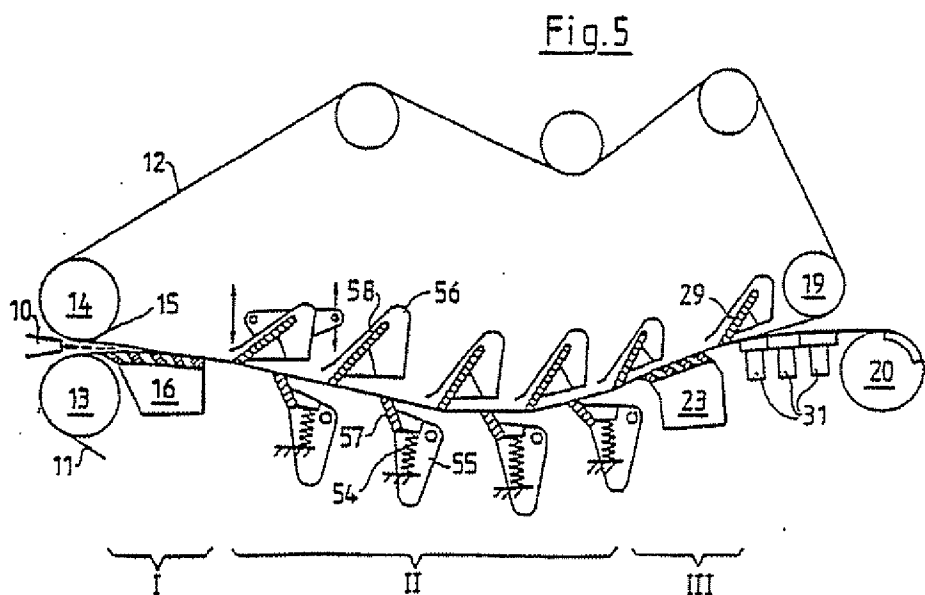
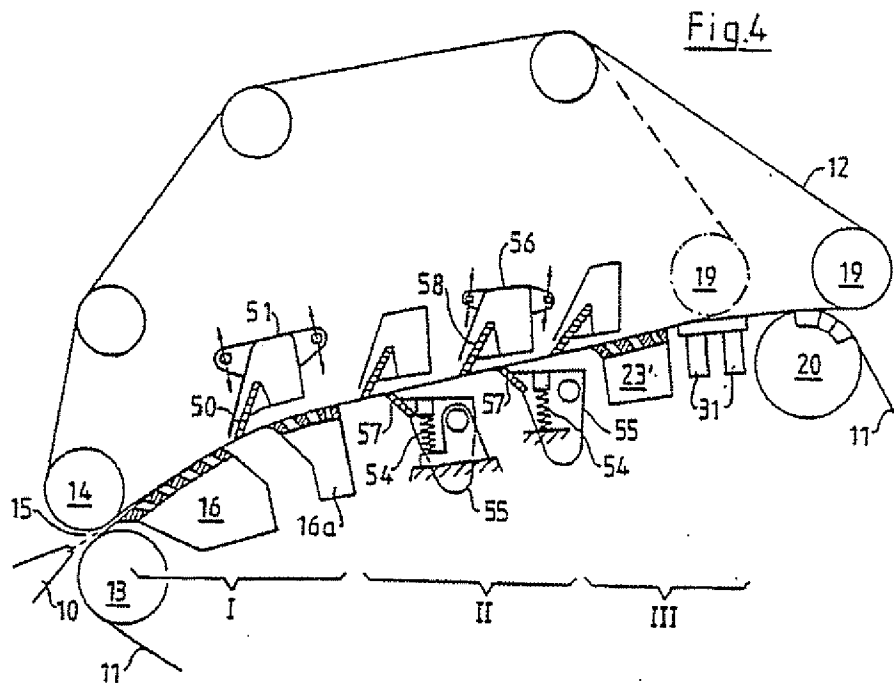


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TWIN-WIRE FORMER

This is a continuation of patent application Ser. No. 08/055,918, filed Apr. 29, 1993, now U.S. Pat. No. 5,389,206 which is a continuation of patent application Ser. No. 07/773,965, filed Nov. 12, 1991, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to a twin-wire former for the production of a fiber web, in particular a paper web, from a fiber suspension. The invention proceeds from the basis of the twin-wire former known from British Patent 1 125 906. The features indicated in the patent include a twin wire former for producing a fiber web and particularly a paper web from a fiber suspension. Two web forming wire belts, in the form of endless loops, travel together to form a twin wire zone. The web travels between and along the path of the wire belts through the twin wire zone. The twin wire zone has three sections and the elements in those three sections are described below. The patent describes features that state, in other words, that the forming of the fiber web from the pulp suspension fed from the headbox takes place exclusively between two wire belts. Thus, there is no so-called single-wire pre-drainage path. In a first section of the twin-wire zone, the two wire belts together form a wedge-shaped inlet slot; a jet of pulp slurry coming from the headbox discharges into it. The jet strikes the two wire belts at a place where they pass over a curved drainage element; in the case of the aforementioned British patent, this is a stationary, curved forming shoe. Its curved wire guide surface is formed of a plurality of strips with drainage slots between them. This forming shoe is followed (in a second section of the twin-wire zone) by a drainage strip arranged in the other wire loop and, behind the latter, by a drainage strip arranged in the first-mentioned wire loop (and formed by a first suction box). Finally, in a third section of the twin-wire zone there are a plurality of stationary drainage elements developed as flat suction boxes.

It has been attempted for decades with twin-wire formers of the known type to produce fiber webs (in particular, paper webs) of the highest possible quality with relatively high operating speeds. Due to the forming of the web between two wires, the result, in particular, is obtained that the final fiber web has substantially the same properties on both sides (little "two-sidedness"). However, it is difficult to obtain as uniform as possible a distribution of the fibers in the final fiber web. In other words, it is difficult to obtain a good "formation", since, while the web is formed, there is always the danger that fibers will agglomerate and form flocculations. Therefore, it is attempted to form a jet of pulp slurry which pulp slurry is as free as possible of flocculations in the headbox (for instance, by means of a turbulence producer). It is, furthermore, endeavored so to influence the drainage of the fiber suspension during the web-forming that "reflocculation" is avoided as far as possible or that, after possible flocculation, a "deflocculation" (i.e. a breaking up of the flocculations) takes place.

It is known that a curved drainage element arranged in the first section of the twin-wire zone and, in particular, a stationary curved forming shoe developed in accordance with the aforementioned British Patent 1 125 906 counteracts the danger of reflocculation. This is true also of the drainage strips arranged in the British Patent in the second section of the twin-wire zone. Nevertheless, the danger of reflocculation is not completely eliminated in the arrangement according to said British Patent. Since the number of

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drainage strips there is very small, a large part of the web-forming takes place in the region of the following flat-suction boxes. They, to be sure, are of high drainage capacity so that the web-forming can be completed in the region of the last flat suction boxes (i.e. the so-called main drainage zone, in which a part of the fiber material is still in the form of a suspension, terminates in the region of the flat suction box). The flat suction boxes, however, are not able to avoid reflocculation or to break up flocculations which have already occurred.

In order to control these last-mentioned difficulties, a web-forming device known under the name of "Duoformer D" has been developed (TAPPI Proceedings 1988 annual meeting, pages 75 to 80). This known web-forming device is part of a twin-wire former which has a single-wire pre-drainage zone. In the twin-wire zone there are provided, in the one wire loop, a plurality of strips which are fixed in position but adjustably supported, namely, on the bottom of a suction box which drains in upward direction. Furthermore, a plurality of resiliently supported strips are provided in the other wire loop. By this resilience of the last-mentioned strips, the following result can be obtained: For example, upon an increase of the amount of suspension entering between the two wire belts, the flexibly supported strips can move away somewhat. In this way, the danger (which is present when only firmly supported strips are used) is eliminated of a backing up taking place in the fiber suspension in front of the strips. Such a backing up could destroy the fiber layers which have been formed up to then on the two wire belts. In other words, with this known web-forming device, a drainage pressure, once established, remains constant due to the resiliently supported strips even upon a change in the amount of suspension fed or upon a change in the drainage behavior of the fiber suspension. Therefore, automatic adaptation of the web-forming device to said changed conditions occurs.

With this known web-forming device, fiber webs of relatively good formation can also be formed. With respect to this, however, the demands have increased considerably recently, so that further improvements are desirable.

SUMMARY OF THE INVENTION

The object of the invention is so to develop a twin-wire of the aforementioned kind that the quality of the fiber web produced is further improved, particularly with respect to its formation (cloudiness), and that the twin-wire former can easily be adapted to different operating conditions (for instance, with regard to quantity and drainage behavior of the fiber suspension).

This object is achieved by the features set forth below. In particular, there is a respective drainage strip above each of the two wire belts in the second section of the twin wire zone, and at least one of the two drainage strips is supported resiliently against the respective wire belt while the other may or may not be resiliently supported, and typically is rigidly supported against the respective wire belt. Preferably, there are at least two of the drainage strips and often more against each of the wire belts. The drainage strips against one belt are offset along the path of the wire belts with respect to the drainage strips against the other belt, providing a zig zag or staggered array, and the drainage strips against at least one of the belts are resiliently supported.

The inventors have found that a combination of known features, namely:

A. Twin-wire former without a single-wire pre-drainage zone

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B. Start of the drainage in the twin-wire zone at a curved drainage element, for instance on a rotating forming cylinder or, even better, on a curved stationary forming shoe

C. Further drainage in the twin-wire zone between strips which are arranged along a "zig-zag" line, the strips which rest against the one wire belt being resiliently supported,

leads to an extremely high increase in the quality of the finished fiber web, so that it satisfies even the highest requirements. At the same time, the twin-wire former of the invention is insensitive to changes in the amount of suspension fed and to changes in the drainage behavior of the fiber suspension. Experiments have shown that it is possible by the invention to obtain both a high increase in quality with respect to the formation and also good values with regard to the retention of fillers and fines. In contradistinction to this, in the known double-wire formers it is constantly found that there is a strong reduction in the retention upon an improvement in the formation.

It was, furthermore, found in experiments that in the second section of the twin-wire zone the number of strips can be considerably reduced as compared with the "Duo-former D". However, this number is substantially greater than in the case of the twin-wire former known from British Patent 1 125 906. It is advantageous to increase the distance between adjacent strips as compared with the "Duo-former D". In particular, the drainage strips above each one of the wire belts are of a thickness along the path of the wire belts and the spacing between adjacent strips above each wire belt is a minimum of about three times the strip thickness.

To be sure, from German OS 31 38 133, FIG. 3, a twin-wire former is known the twin-wire zone of which is provided in a first section with a curved stationary drainage element and in a second section with strips arranged along a "zig-zag" line, which strips may also be resiliently supported and there being a relatively large distance between them. However, in that case, in front of the twin-wire zone there is a single-wire pre-drainage zone in which the forming of the web starts initially only in a lower layer of the fiber suspension fed while the upper layer remains liquid and tends very strongly to flocculation. It has been found that these flakes cannot be broken up again to the desired extent in the following twin-wire zone. Another disadvantage is that the twin-wire zone is diverted by a guide roll (14b) behind the second section. This results (due to the so-called table-roll effect) in a further drainage which is uneven over the width of the web and thus in undesired variations in the quality of the web (recognizable, for instance, by disturbing longitudinal stripes).

BRIEF DESCRIPTION OF THE DRAWINGS

Other developments of the invention will be explained below with reference to embodiments which are shown in the drawing. Each of FIGS. 1 to 5 shows—in simplified diagrammatic form—one of the different embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The twin-wire former shown in FIG. 1 has a substantially horizontally extending twin-wire zone; this zone comprises three sections I, II and III arranged one behind the other. The endless wire belts (lower wire 11 and upper wire 12), shown only in part, travel in the direct vicinity of a headbox 10 over, in each case, a breast roll 13 and 14 respectively, so

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that the two wire belts together form a wedge-shaped entry slot 15 at the start of the twin-wire zone. The jet pulp discharged by the headbox 10 comes into contact with the two wire belts 11 and 12 only at the place where the lower wire 11 in the first section I of the twin-wire zone travels over a stationary curved forming shoe 16. The curved travel surface thereof is formed of several strips 16' with drainage slits present between them. The distance between the two breast rolls 13 and 14 is variable. The forming shoe 16 can be operated with or without vacuum.

In the second section II of the twin-wire zone, the two wire belts 11 and 12 (with the partially still liquid fiber suspension present between them) travel between a lower drainage box 17 and an upper drainage box 18. In the lower drainage box 17 there are a row of at least two strips 27 (preferably of approximately rectangular cross section) which are pressed from below resiliently against the lower wire 11. For this purpose, they are supported, for instance, on springs 24 (or pneumatic pressure cushions) on a, preferably water-permeable, plate. It is obvious that the force of the springs (or of the pressure prevailing in the pressure cushions) is individually adjustable.

The upper drainage box 18 is suspended on both the front and rear ends on vertically displaceable support elements as indicated diagrammatically by double arrows. On its lower side, there is a row of at least three strips 28 of preferably parallelogram cross section which rest against the upper side of the upper wire 12 and are rigidly attached to the box 18. Above the strips 28, a front vacuum chamber 21 and a rear vacuum chamber 22 are present in the drainage box 18. In the region of the forming shoe 16, a part of the water of the fiber suspension is led off downward; another part penetrates due to the tension of the upper wire 12—upwards through the upper wire and is deflected by the furthest in front of the strips 28 into the front vacuum chamber 21. The water passing upward between the upper strips 28 enters into the rear vacuum chamber 22. The water penetrating between the lower strips 27 through the lower wire 11 is led off downward. Between adjacent upper drainage strips 28 there is a minimum distance X of about three times the thickness Y of the strips. The same is true of the lower resiliently supported strips 27. It is important that each of the strips 27 and 28 lies in the region of a space between two opposite strips so that a "zig-zag" arrangement (i.e. non-opposing relationship) is present. Also, as seen in FIG. 1, the first one of the strips 28 is located upstream of the first one of the strips 27. The two wires 11 and 12 preferably travel on a straight path through section II. Gentle curvature of this section of the path is, however, also possible; see FIGS. 2 and 5. Differing from FIG. 1, the resiliently supported strips could also be arranged in the upper box 18 and the firmly supported strips in the lower box 17.

In the third section III of the twin-wire zone, both wire belts 11 and 12 travel over another curved forming shoe 23 which (as shown) is arranged preferably in the lower wire loop 11. Behind it, an additional strip 29 with vacuum chamber 30 can be arranged in the loop of the upper wire 12. Furthermore, flat suction boxes 31 can be present in the loop of the lower wire. There (as is shown by dash-dot lines) the upper wire 12 can be separated by means of a guide roll 19 from the lower wire 11 and from the fiber web formed. Lower wire and fiber web then travel over a wire suction roll 20. The guide roll 19 can, however, also lie further back, so that the upper wire 12 is separated from the lower wire 11 only on the wire suction roll 20.

It is important that two drainage boxes 17 and 18 with the alternately resiliently and firmly supported ledge strips 27

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and 28 lie not in the front or the rear sections but in the middle section II of the twin-wire zone, since only here can they develop their full effect, namely, intensive drainage of the fiber suspension fed while retaining the fine flocculation-free fiber distribution. This is achieved in the manner that the corresponding wire belt is imparted a slight (scarcely visible) deflection on each strip so that turbulence is constantly produced in the still liquid part of the fiber pulp. For success it is, however, also decisive that previously, in section I, a known pre-drainage towards both sides has already taken place and that this also takes place with the greatest possible retention of the flocculation-free condition of the fiber suspension.

For this two-sided pre-drainage, a stationary curved forming shoe is provided in the first section I of the twin-wire zone (in accordance with FIGS. 1 and 3-5) whenever it is a question of satisfying the highest quality demands with respect to the formation. This effect of the forming shoe is due to the fact that at least the one wire belt travels polygonally from strip to strip, each strip not only leading water away but also producing turbulence in the pulp which is still liquid. With such a forming shoe, it is, however, difficult at times to obtain a stable operating condition upon the starting of the paper machine. Therefore, it may be advantageous to provide a known forming roll 40 in accordance with FIG. 2 in Section I instead of the stationary forming shoe and the breast roll lying in front of it. This possibility will be utilized when, in particular, the highest productivity is demanded from the paper manufacturing machine.

In the third section III, the aforementioned strip 29 can serve either solely to lead away water upwards or, in addition, for the further production of turbulence (for further improvement in quality). The latter is possible if a part of the fiber pulp is still in liquid condition at this place.

In FIGS. 1 to 3, the distance between the two wires 11 and 12 in the twin-wire zone has been shown greatly exaggerated. By this, it is intended to make it clear that the two wires 11 and 12 converge towards each other over a relatively long path within the twin-wire zone. This makes it clear that the process of web-forming on the first forming shoe 16 (in Section I) commences relatively slowly and is completed only in Section III. In this connection, the end of the main drainage zone in which the two wires converge towards each other (and thus, the end of the web-forming process) can lie approximately in the center of the wrapping zone of the second forming shoe 23, as is indicated, merely by way of example, in FIGS. 1 to 3. The end of the wire convergence is symbolically indicated there by the point E; the solids content of the paper web has reached there approximately the value of 8%. This point can, however, also lie, for instance, on one of the flat suction boxes 31. Behind this point, it is attempted further to increase the solids content, if possible even before the separation of the two wires. One goal is, namely, for the separation of the wires to take place with the highest possible solids content of the web so that as few fibers as possible are torn out of the web upon the separation. The nature and number of the drainage elements necessary for this within the twin-wire zone may, however, differ greatly and is dependent, among other things, on the type of paper and the raw-material components thereof, as well as on the operating speed.

The embodiments shown in FIGS. 2 and 3 differ from the others primarily by the fact that the twin-wire zone rises substantially vertically upward in the direction of travel of the wires. In this way, the removal of the water withdrawn from the fiber suspension is simplified since the water can be

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discharged relatively uniformly towards both sides. No vacuum chambers are required in particular in the central section II of the twin-wire zone. To be sure, the forming roll 40 of FIG. 2 is, as a rule, developed as a suction roll. The forming shoes 16, 23, particularly those arranged in the third section III, can, if necessary, be provided with a suction device.

Further elements of the twin-wire former shown in FIG. 2 are water-collection containers 41, 42 and 43, guide plates 44 associated with the fixed strips 28, and a water removal strip 45. The other elements are provided with the same reference numbers as the corresponding elements in FIG. 1. The same is true with regard to FIG. 3. One possible modification of FIG. 3 can consist therein that, instead of the wire suction roll 20, a forming roll is provided, and instead of the guide roll 19 the wire suction roll. A similar arrangement is known from German Utility Model 88 06 036 (Voith File: P 4539). Aside from this exception and aside from the embodiment according to FIG. 2 (with forming roll 40), the invention will, however, be used—whenever possible—so to design the twin-wire former that the relatively expensive forming roll (as to purchase and operation) can be dispensed with. Thus, as a rule, the wire suction roll 20 is present as the sole suction roll. Furthermore, in all embodiments of the invention it can be seen to it that no guide roll which deflects the twin-wire zone (and has the above-mentioned injurious table-roll effect) is present.

The embodiment of FIG. 4 differs from FIG. 1 among other things by the fact that, in the first section I of the twin-wire zone, a second curved stationary forming shoe 16a is arranged in the loop of the lower wire 11 behind and spaced from a first curved stationary forming shoe 16. Furthermore, in the loop of the upper wire 12 in the region between the two stationary forming shoes 16 and 16a there is provided an individual strip 50 which in known manner is part of a vacuum chamber 51. This vacuum chamber 51, similar to the upper drainage box 18 of FIG. 1, is suspended on its front and rear ends in vertically displaceable mounts. In this way, both the depth of penetration of the strip 50 into the path of travel of the upper wire 12 as well as the angle of attack of the strip 50 can be varied. With slight depth of penetration, the strip 50 serves solely for removal of water, while with greater depth of penetration it serves, in addition, for the production of turbulence in the suspension and, thus, for improvement of the formation. By the presence of two separate forming shoes 16 and 16a, the pre-drainage on both sides is temporarily interrupted; it is only continued after the strip 50 has removed from the upper wire 12 the water which has penetrated upward on the first forming shoe 16. In this way, higher operating speeds are possible.

Another difference from FIG. 1 is that, in the second section II of the twin-wire zone, the lower, flexibly supported strips 57 and the upper, firmly supported strips 58 are developed as individual strips. This means that each strip has its own supporting body 55/56. The lower strip-supporting bodies 55 are swingably mounted, the strip 57 being pressed resiliently by the force of springs 54 against the bottom of the lower wire 11. The supporting body 56 of each of the upper strips 58 is developed as vacuum chamber in the same way as that of the strip 50. The suspension of these vacuum chambers 56 corresponds to that of the vacuum chamber 51. It is important that each of the strips 57 and 58 rest with a given force of application (corresponding to the suspension pressure) against its wire belt 11 or 12. The strips 57 and 58 are adjusted in such a manner that a slight deflection of the wire belts takes place preferably on each strip. Due to the resilient supporting of the lower strips 57, the adjustment,

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once effected, is insensitive to changes in the quantity or quality of pulp, so that no backing up takes place in front of the strips and, nevertheless, an effective introduction of turbulence forces into the fiber suspension takes place. In contradistinction to FIGS. 1 to 3, there is the possibility of adjusting each one of the strips 57/58 individually with respect to position in height and inclination relative to the travel path of the wire. In this way, one can even better control the quality of the paper produced, with respect to both the formation and the nature of its surface (printability). Differing from FIG. 4, the upper strips 58 could be supported resiliently and the lower strips 57 stationary. Another alternative could consist therein that not only the upper strips 58 but also the lower strips 57 are fastened in vertically displaceable mounts (as shown on the vacuum chamber 51). In such case, the springs 54 might possibly be eliminated.

Another difference between FIGS. 1 and 4 resides in the fact that in FIG. 4 the twin-wire zone rises in the direction of travel of the wires upwards with an inclination of, on the average, about 20° with respect to the horizontal. In this way, it is possible to keep the entire height of the twin-wire former relatively slight. In the third section III of the twin-wire zone, a flat forming shoe 23' is provided rather than a curved one, differing from FIG. 1. The separation of the upper wire 12 from the lower wire and the fiber web formed can take place, as in FIG. 1, on one of the flat suction boxes 31. Instead of this, however, the upper wire 12 can also be conducted up to the wire suction roll 20. There, as shown, it can wrap around a small part (or, alternatively, a larger part) of the circumference of the wire suction roll and then be returned via the reversing roll 19.

In the embodiment shown in FIG. 5, the twin-wire zone, as a whole, extends substantially in horizontal direction. The individual elements are substantially the same as in the embodiment of FIG. 4. However, there is the difference that the drainage strips 57 and 58 lying in the second section II of the twin-wire zone are arranged along a downwardly curved path of the twin-wire zone. Accordingly, an upwardly curved forming shoe 16, 23 is provided in the first section I and in the third section III of the twin-wire zone. This embodiment is advisable, in particular, for the modernizing of existing Fourdrinier paper machines.

The embodiments shown have the feature in common that, in the second section II of the twin-wire zone, there are present preferably n flexibly supported strips 27/57 and $n+1$ rigidly supported strips. However, it is also possible to make the number of flexibly supported strips equal to or greater by one than the number of rigidly supported strips. Instead of a rigidly supported strip, a feed or discharge edge of a drainage box can also be provided. The minimum number n of flexibly supported strips is two (see FIG. 4). However, three or four flexibly supported strips are preferred.

What is claimed is:

1. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section at the start of the path through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into

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the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone; a curved drainage element in the first section, the curved drainage element having an open surface to enable drainage of water from the fiber suspension and being curved along the path of the belts through the twin wire zone, the curved drainage element being engaged by one of the wire belts, for curving the path of the belts around the curved drainage element after the entrance of the suspension into the entrance slot;

the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone; in the second section, a plurality of first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that strip contacts;

second support means supporting the second drainage strips rigidly against the second wire belt;

the first drainage strips being located within the same wire belt loop as the curved drainage element and the second drainage strips being located within the other wire belt loop; the first one of the second drainage strips being located upstream of the first one of the first drainage strips and the last one of the second drainage strips being located downstream of the last one of the first drainage strips;

means for supplying a vacuum in the area of the second drainage strips;

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a drainage element in the third section, for being engaged by one of the wire belts as the wire belts travel over the drainage element, the drainage element having an open surface to enable water to be drained through the wire belt in contact therewith; and

the twin wire zone being free of rolls which deflect the twin wire zone.

2. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section at the start of the path through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone; a curved drainage element in the first section, the

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curved drainage element having an open surface to enable drainage of water from the fiber suspension and being curved along the path of the belts through the twin wire zone, the curved drainage element being engaged by one of the wire belts, for curving the path of the belts around the curved drainage element after the entrance of the suspension into the entrance slot; the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone; in the second section, a plurality of first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that strip contacts; second support means supporting the second drainage strips rigidly against the second wire belt;

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the first drainage strips being located within the same wire belt loop as the curved drainage element and the second drainage strips being located within the other wire belt loop; the first one of the second drainage strips being located upstream of the first one of the first drainage strips and the last one of the second drainage strips being located downstream of the last one of the first drainage strips;

means for supplying a vacuum in the area of the second drainage strips;

the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a drainage element in the third section, for being engaged by one of the wire belts as the wire belts travel over the stationary drainage element, the drainage element having an open surface to enable water to be drained through the wire belt in contact therewith; and

the twin wire zone being free of any forming rolls.

* * * * *

Exhibit 5



US005389206A

United States Patent [19]

Bück et al.

[11] Patent Number: **5,389,206**[45] Date of Patent: **Feb. 14, 1995**[54] **TWIN WIRE FORMER**

[75] Inventors: Rudolf Bück; Dieter Egelhof; Klaus Henseler, all of Heidenheim, Germany; Werner Kade, Neenah, Wis.; Albrecht Melnecke, Heidenheim, Germany; Wilhelm Wanke, Heidenheim, Germany; Hans-Jürgen Wulz, Heidenheim, Germany

[73] Assignee: J. M. Voith GmbH, Germany

[21] Appl. No.: 55,918

[22] Filed: Apr. 29, 1993

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Related U.S. Application Data

[63] Continuation of Ser. No. 773,965, filed as PCT/EP90/01313, Aug. 9, 1990, abandoned.

[30] **Foreign Application Priority Data**

Aug. 22, 1989 [DE] Germany 3927597

[51] Int. Cl.⁶ D21F 1/00

[52] U.S. Cl. 162/301; 162/300

[58] Field of Search 162/203, 300, 301, 303, 162/348, 352

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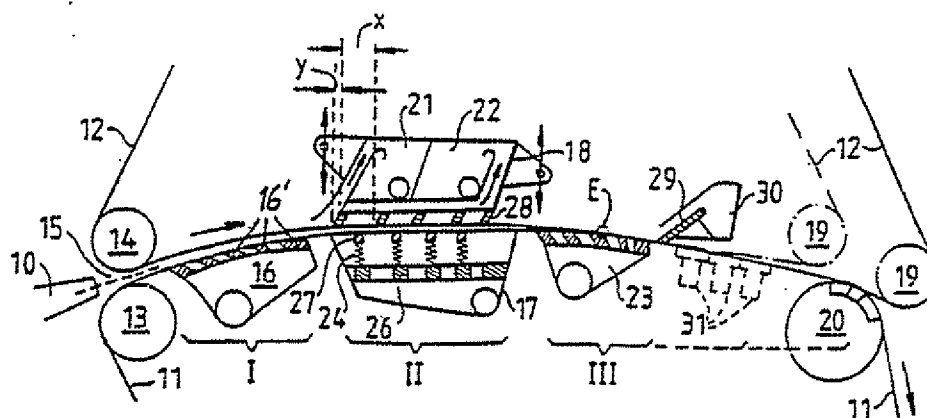
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Primary Examiner—Karen M. Hastings
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

In a twin-wire former for the production of a paper web, two wire belts (11 and 12) together form a twin-wire zone which is divided into three sections (I, II and III). In the first section (I) the two wires (11, 12) travel over a curved forming shoe (16). They form there a wedge-shaped inlet slot (15) with which a headbox (10) is directly associated. In the second section (II), several resiliently supported strips (27) rest against the lower wire (11) and between each of said strips (27) a rigidly mounted strip (28) rests against the upper wire (12). In the third section (III) both wire belts (11, 12) pass over another curved forming shoe (23).

18 Claims, 2 Drawing Sheets



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Fig.1

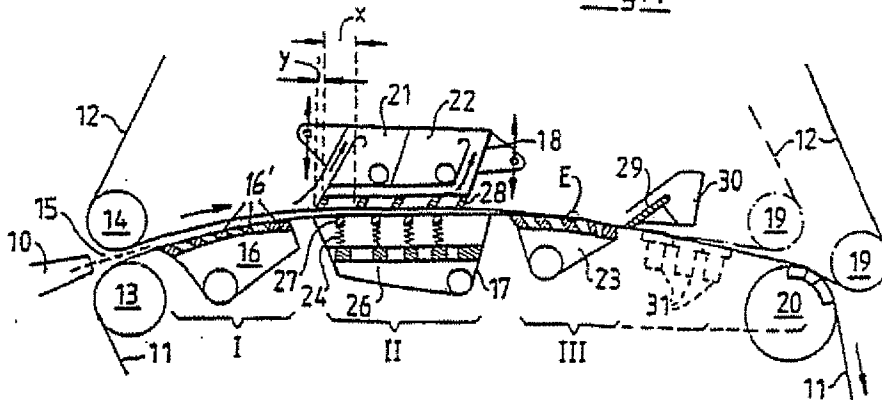


Fig.2

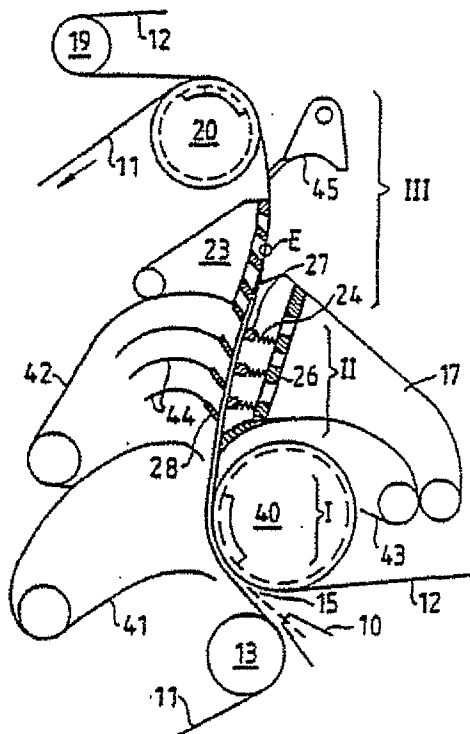
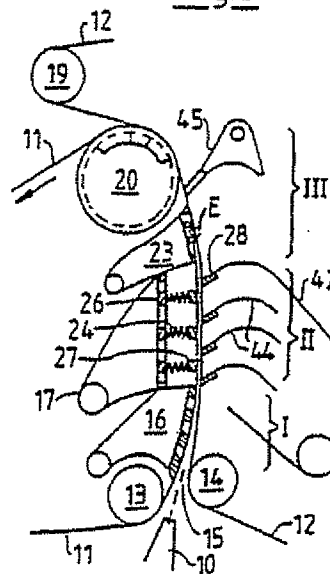


Fig.3

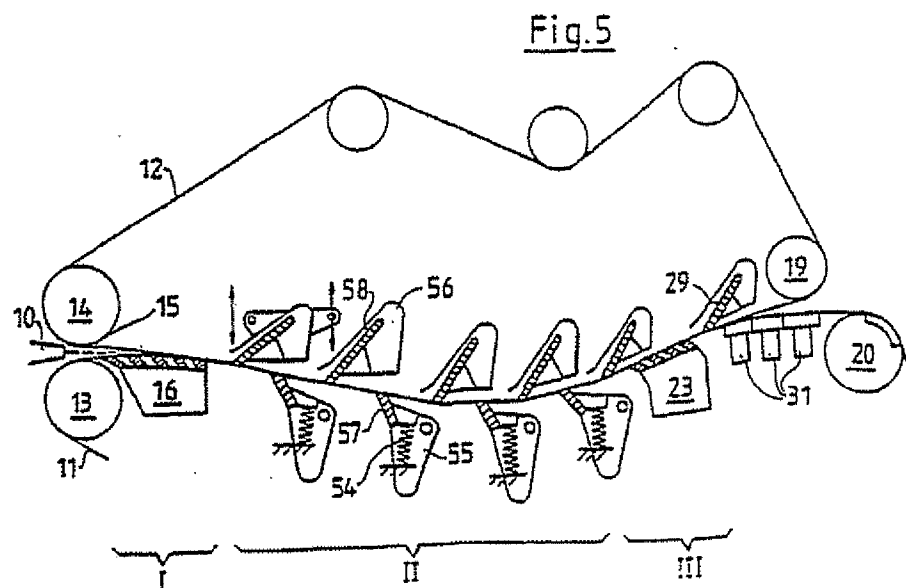
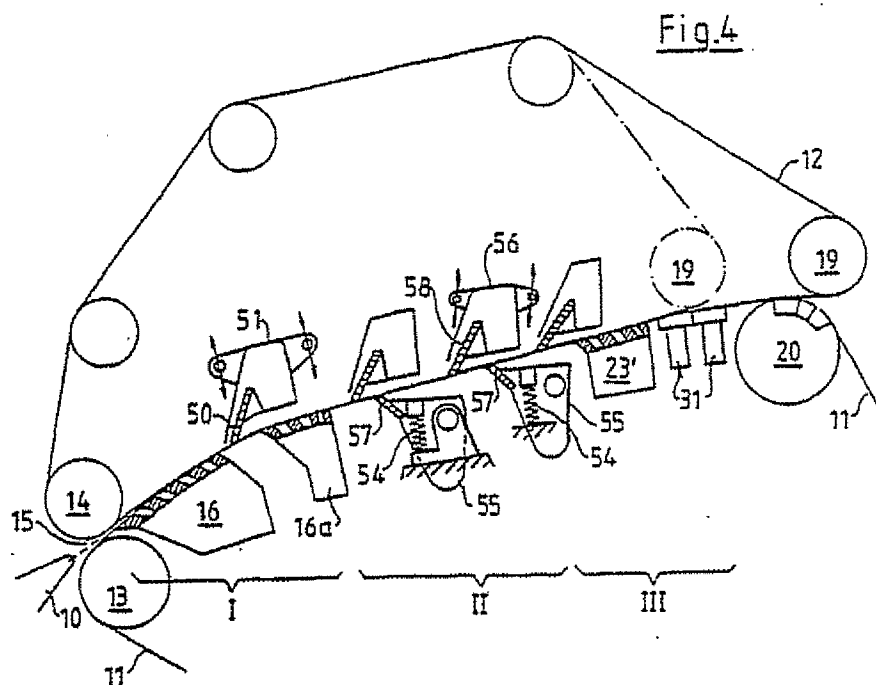


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TWIN WIRE FORMER

This is a continuation of application Ser. No. 07/773,965, filed as PCT/EP90/01313, Aug. 9, 1990, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to a twin-wire former for the production of a fiber web, in particular a paper web, from a fiber suspension. The invention proceeds from the basis of the twin-wire former known from British Patent 1 125 906. The features indicated in the patent include a twin wire former for producing a fiber web and particularly a paper web from a fiber suspension. Two web forming wire belts, in the form of endless loops, travel together to form a twin wire zone. The web travels between and along the path of the wire belts through the twin wire zone. The twin wire zone has three sections and the elements in those three sections are described below. The patent describes features that state, in other words, that the forming of the fiber web from the pulp suspension fed from the headbox takes place exclusively between two wire belts. Thus, there is no so-called single-wire pre-drainage path. In a first section of the twin-wire zone, the two wire belts together form a wedge-shaped inlet slot; a jet of pulp slurry coming from the headbox discharges into it. The jet strikes the two wire belts at a place where they pass over a curved drainage element; in the case of the aforementioned British patent, this is a stationary, curved forming shoe. Its curved wire guide surface is formed of a plurality of strips with drainage slots between them. This forming shoe is followed (in a second section of the twin-wire zone) by a drainage strip arranged in the other wire loop and, behind the latter, by a drainage strip arranged in the first-mentioned wire loop (and formed by a first suction box). Finally, in a third section of the twin-wire zone there are a plurality of stationary drainage elements developed as flat suction boxes.

It has been attempted for decades with twin-wire formers of the known type to produce fiber webs (in particular, paper webs) of the highest possible quality with relatively high operating speeds. Due to the forming of the web between two wires, the result, in particular, is obtained that the final fiber web has substantially the same properties on both sides (little "two-sidedness"). However, it is difficult to obtain as uniform as possible a distribution of the fibers in the final fiber web. In other words, it is difficult to obtain a good "formation" since while the web is formed, there is always the danger that fibers will agglomerate and form flocculations. Therefore, it is attempted to form a jet of pulp slurry which pulp slurry is as free as possible of flocculations in the headbox (for instance, by means of a turbulence producer). It is, furthermore, endeavored so to influence the drainage of the fiber suspension during the web-forming that "reflocculation" is avoided as far as possible or that, after possible flocculation, a "deflocculation" (i.e. a breaking up of the flocculations) takes place.

It is known that a curved drainage element arranged in the first section of the twin-wire zone and, in particular, a stationary curved forming shoe developed in accordance with the aforementioned British Patent 1 125 906 counteracts the danger of reflocculation. This is true also of the drainage strips arranged in the British Patent in the second section of the twin-wire zone. Nevertheless, the danger of reflocculation is not com-

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pletely eliminated in the arrangement according to said British Patent. Since the number of drainage strips there is very small, a large part of the web-forming takes place in the region of the following flat-suction boxes. They, to be sure, are of high drainage capacity so that the web-forming can be completed in the region of the last flat suction boxes (i.e. the so-called main drainage zone, in which a part of the fiber material is still in the form of a suspension, terminates in the region of the flat suction box). The flat suction boxes, however, are not able to avoid reflocculation or to break up flocculations which have already occurred.

In order to control these last-mentioned difficulties, a web-forming device known under the name of "Duo-former D" has been developed (TAPPI Proceedings 1988 annual meeting, pages 75 to 80). This known web-forming device is part of a twin-wire former which has a single-wire pre-drainage zone. In the twin-wire zone there are provided, in the one wire loop, a plurality of strips which are fixed in position but adjustably supported, namely, on the bottom of a suction box which drains in upward direction. Furthermore, a plurality of resiliently supported strips are provided in the other wire loop. By this resilience of the last-mentioned strips, the following result can be obtained: For example, upon an increase of the amount of suspension entering between the two wire belts, the flexibly supported strips can move away somewhat. In this way, the danger (which is present when only firmly supported strips are used) is eliminated of a backing up taking place in the fiber suspension in front of the strips. Such a backing up could destroy the fiber layers which have been formed up to then on the two wire belts. In other words, with this known web-forming device, a drainage pressure, once established, remains constant due to the resiliently supported strips even upon a change in the amount of suspension fed or upon a change in the drainage behavior of the fiber suspension. Therefore, automatic adaptation of the web-forming device to said changed conditions occurs.

With this known web-forming device, fiber webs of relatively good formation can also be formed. With respect to this, however, the demands have increased considerably recently, so that further improvements are desirable.

SUMMARY OF THE INVENTION

The object of the invention is so to develop a twin-wire of the aforementioned kind that the quality of the fiber web produced is further improved, particularly with respect to its formation (cloudiness), and that the twin-wire former can easily be adapted to different operating conditions (for instance, with regard to quantity and drainage behavior of the fiber suspension).

This object is achieved by the features set forth below. In particular, there is a respective drainage strip above each of the two wire belts in the second section of the twin wire zone, and at least one of the two drainage strips is supported resiliently against the respective wire belt while the other may or may not be resiliently supported, and typically is rigidly supported against the respective wire belt. Preferably, there are at least two of the drainage strips and often more against each of the wire belts. The drainage strips against one belt are offset along the path of the wire belts with respect to the drainage strips against the other belt, providing a zig zag or staggered array, and the drainage strips against at least one of the belts are resiliently supported.

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The inventors have found that a combination of known features, namely:

- A. Twin-wire former without a single-wire pre-drainage zone
- B. Start of the drainage in the twin-wire zone at a curved drainage element, for instance on a rotating forming cylinder or, even better, on a curved stationary forming shoe
- C. Further drainage in the twin-wire zone between strips which are arranged along a "zig-zag" line, the strips which rest against the one wire belt being resiliently supported,

leads to an extremely high increase in the quality of the finished fiber web, so that it satisfies even the highest requirements. At the same time, the twin-wire former of the invention is insensitive to changes in the amount of suspension fed and to changes in the drainage behavior of the fiber suspension. Experiments have shown that it is possible by the invention to obtain both a high increase in quality with respect to the formation and also good values with regard to the retention of fillers and fines. In contradistinction to this, in the known double-wire formers it is constantly found that there is a strong reduction in the retention upon an improvement in the formation.

It was, furthermore, found in experiments that in the second section of the twin-wire zone the number of strips can be considerably reduced as compared with the "Duoformer D". However, this number is substantially greater than in the case of the twin-wire former known from British Patent 1 125 906. It is advantageous to increase the distance between adjacent strips as compared with the "Duoformer D". In particular, the drainage strips above each one of the wire belts are of a thickness along the path of the wire belts and the spacing between adjacent strips above each wire belt is a minimum of about three times the strip thickness.

To be sure, from German OS 31 38 133, FIG. 3, a twin-wire former is known the twin-wire zone of which is provided in a first section with a curved stationary drainage element and in a second section with strips arranged along a "zig-zag" line, which strips may also be resiliently supported and there being a relatively large distance between them. However, in that case, in front of the twin-wire zone there is a single-wire pre-drainage zone in which the forming of the web starts initially only in a lower layer of the fiber suspension fed while the upper layer remains liquid and tends very strongly to flocculation. It has been found that these flakes cannot be broken up again to the desired extent in the following twin-wire zone. Another disadvantage is that the twin-wire zone is diverted by a guide roll (14b) behind the second section. This results (due to the so-called table-roll effect) in a further drainage which is uneven over the width of the web and thus in undesired variations in the quality of the web (recognizable, for instance, by disturbing longitudinal stripes).

BRIEF DESCRIPTION OF THE DRAWINGS

Other developments of the invention will be explained below with reference to embodiments which are shown in the drawing. Each of FIGS. 1 to 5 shows—in simplified diagrammatic form—one of the different embodiments.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The twin-wire former shown in FIG. 1 has a substantially horizontally extending twin-wire zone; this zone comprises three sections I, II and III arranged one behind the other. The endless wire belts (lower wire 11 and upper wire 12), shown only in part, travel in the direct vicinity of a headbox 10 over, in each case, a breast roll 13 and 14 respectively, so that the two wire belts together form a wedge-shaped entry slot 15 at the start of the twin-wire zone. The jet pulp discharged by the headbox 10 comes into contact with the two wire belts 11 and 12 only at the place where the lower wire 11 in the first section I of the twin-wire zone travels over a stationary curved forming shoe 16. The curved travel surface thereof is formed of several strips 16' with drainage slits present between them. The distance between the two breast rolls 13 and 14 is variable. The forming shoe 16 can be operated with or without vacuum.

In the second section II of the twin-wire zone, the two wire belts 11 and 12 (with the partially still liquid fiber suspension present between them) travel between a lower drainage box 17 and an upper drainage box 18. In the lower drainage box 17 there are a row of at least two strips 27 (preferably of approximately rectangular cross section) which are pressed from below resiliently against the lower wire 11. For this purpose, they are supported, for instance, on springs 24 (or pneumatic pressure cushions) on a, preferably water-permeable, plate. It is obvious that the force of the springs (or of the pressure prevailing in the pressure cushions) is individually adjustable.

The upper drainage box 18 is suspended on both the front and rear ends on vertically displaceable support elements as indicated diagrammatically by double arrows. On its lower side, there is a row of at least three strips 28 of preferably parallelogram cross section which rest against the upper side of the upper wire 12 and are rigidly attached to the box 18. Above the strips 28, a front vacuum chamber 21 and a rear vacuum chamber 22 are present in the drainage box 18. In the region of the forming shoe 16, a part of the water of the fiber suspension is led off downward; another part penetrates due to the tension of the upper wire 12—upwards through the upper wire and is deflected by the furthest in front of the strips 28 into the front vacuum chamber 21. The water passing upward between the upper strips 28 enters into the rear vacuum chamber 22. The water penetrating between the lower strips 27 through the lower wire 11 is led off downward. Between adjacent upper drainage strips 28 there is a minimum distance X of about three times the thickness Y of the strips. The same is true of the lower resiliently supported strips 27. It is important that each of the strips 27 and 28 lies in the region of a space between two opposite strips so that a "zig-zag" arrangement (i.e. non-opposing relationship) is present. Also, as seen in FIG. 1, the first one of the strips 28 is located upstream of the first one of the strips 27. The two wires 11 and 12 preferably travel on a straight path through section II. Gentle curvature of this section of the path is, however, also possible; see FIGS. 2 and 5. Differing from FIG. 1, the resiliently supported strips could also be arranged in the upper box 18 and the firmly supported strips in the lower box 17.

In the third section III of the twin-wire zone, both wire belts 11 and 12 travel over another curved forming

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shoe 23 which (as shown) is arranged preferably in the lower wire loop 11. Behind it, an additional strip 29 with vacuum chamber 30 can be arranged in the loop of the upper wire 12. Furthermore, flat suction boxes 31 can be present in the loop of the lower wire. There (as is shown by dash-dot lines) the upper wire 12 can be separated by means of a guide roll 19 from the lower wire 11 and from the fiber web formed. Lower wire and fiber web then travel over a wire suction roll 20. The guide roll 19 can, however, also lie further back, so that the upper wire 12 is separated from the lower wire 11 only on the wire suction roll 20.

It is important that two drainage boxes 17 and 18 with the alternately resiliently and firmly supported ledge strips 27 and 28 lie not in the front or the rear sections but in the middle section II of the twin-wire zone, since only here can they develop their full effect, namely, intensive drainage of the fiber suspension fed while retaining the fine flocculation-free fiber distribution. This is achieved in the manner that the corresponding wire belt is imparted a slight (scarcely visible) deflection on each strip so that turbulence is constantly produced in the still liquid part of the fiber pulp. For success it is, however, also decisive that previously, in section I, a known pre-drainage towards both sides has already taken place and that this also takes place with the greatest possible retention of the flocculation-free condition of the fiber suspension.

For this two-sided pre-drainage, a stationary curved forming shoe is provided in the first section I of the twin-wire zone (in accordance with FIGS. 1 and 3-5) whenever it is a question of satisfying the highest quality demands with respect to the formation. This effect of the forming shoe is due to the fact that at least the one wire belt travels polygonally from strip to strip, each strip not only leading water away but also producing turbulence in the pulp which is still liquid. With such a forming shoe, it is, however, difficult at times to obtain a stable operating condition upon the starting of the paper machine. Therefore, it may be advantageous to provide a known forming roll 40 in accordance with FIG. 2 in Section I instead of the stationary forming shoe and the breast roll lying in front of it. This possibility will be utilized when, in particular, the highest productivity is demanded from the paper manufacturing machine.

In the third section III, the aforementioned strip 29 can serve either solely to lead away water upwards or, in addition, for the further production of turbulence (for further improvement in quality). The latter is possible if a part of the fiber pulp is still in liquid condition at this place.

In FIGS. 1 to 3, the distance between the two wires 11 and 12 in the twin-wire zone has been shown greatly exaggerated. By this, it is intended to make it clear that the two wires 11 and 12 converge towards each other over a relatively long path within the twin-wire zone. This makes it clear that the process of web-forming on the first forming shoe 16 (in Section I) commences relatively slowly and is completed only in Section III. In this connection, the end of the main drainage zone in which the two wires converge towards each other (and thus, the end of the web-forming process) can lie approximately in the center of the wrapping zone of the second forming shoe 23, as is indicated, merely by way of example, in FIGS. 1 to 3. The end of the wire convergence is symbolically indicated there by the point E; the solids content of the paper web has reached there ap-

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proximately the value of 8%. This point can, however, also lie, for instance, on one of the flat suction boxes 31. Behind this point, it is attempted further to increase the solids content, if possible even before the separation of the two wires. One goal is, namely, for the separation of the wires to take place with the highest possible solids content of the web so that as few fibers as possible are torn out of the web upon the separation. The nature and number of the drainage elements necessary for this within the twin-wire zone may, however, differ greatly and is dependent, among other things, on the type of paper and the raw-material components thereof, as well as on the operating speed.

The embodiments shown in FIGS. 2 and 3 differ from the others primarily by the fact that the twin-wire zone rises substantially vertically upward in the direction of travel of the wires. In this way, the removal of the water withdrawn from the fiber suspension is simplified since the water can be discharged relatively uniformly towards both sides. No vacuum chambers are required in particular in the central section II of the twin-wire zone. To be sure, the forming roll 40 of FIG. 2 is, as a rule, developed as a suction roll. The forming shoes 16, 23, particularly those arranged in the third section III, can, if necessary, be provided with a suction device.

Further elements of the twin-wire former shown in FIG. 2 are water-collection containers 41, 42 and 43, guide plates 44 associated with the fixed strips 28, and a water removal strip 45. The other elements are provided with the same reference numbers as the corresponding elements in FIG. 1. The same is true with regard to FIG. 3. One possible modification of FIG. 3 can consist therein that, instead of the wire suction roll 20, a forming roll is provided, and instead of the guide roll 19 the wire suction roll. A similar arrangement is known from German Utility Model 88 06 036 (Voith File: P 4539). Aside from this exception and aside from the embodiment according to FIG. 2 (with forming roll 40), the invention will, however, be used whenever possible—so to design the twin-wire former that the relatively expensive forming roll (as to purchase and operation) can be dispensed with. Thus, as a rule, the wire suction roll 20 is present as the sole suction roll. Furthermore, in all embodiments of the invention it can be seen to it that no guide roll which deflects the twin-wire zone (and has the above-mentioned injurious table-roll effect) is present.

The embodiment of FIG. 4 differs from FIG. 1 among other things by the fact that, in the first section I of the twin-wire zone, a second curved stationary forming shoe 16a is arranged in the loop of the lower wire 11 behind and spaced from a first curved stationary forming shoe 16. Furthermore, in the loop of the upper wire 12 in the region between the two stationary forming shoes 16 and 16a there is provided an individual strip 50 which in known manner is part of a vacuum chamber 51. This vacuum chamber 51, similar to the upper drainage box 18 of FIG. 1, is suspended on its front and rear ends in vertically displaceable mounts. In this way, both the depth of penetration of the strip 50 into the path of travel of the upper wire 12 as well as the angle of attack of the strip 50 can be varied. With slight depth of penetration, the strip 50 serves solely for removal of water, while with greater depth of penetration it serves, in addition, for the production of turbulence in the suspension and, thus, for improvement of the formation. By the presence of two separate forming shoes 16 and 16a, the pre-drainage on both sides is temporarily

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interrupted; it is only continued after the strip 50 has removed from the upper wire 12 the water which has penetrated upward on the first forming shoe 16. In this way, higher operating speeds are possible.

Another difference from FIG. 1 is that, in the second section II of the twin-wire zone, the lower, flexibly supported strips 57 and the upper, firmly supported strips 58 are developed as individual strips. This means that each strip has its own supporting body 55/56. The lower strip-supporting bodies 55 are swingably mounted, the strip 57 being pressed resiliently by the force of springs 54 against the bottom of the lower wire 11. The supporting body 56 of each of the upper strips 58 is developed as vacuum chamber in the same way as that of the strip 50. The suspension of these vacuum chambers 56 corresponds to that of the vacuum chamber 51. It is important that each of the strips 57 and 58 rest with a given force of application (corresponding to the suspension pressure) against its wire belt 11 or 12. The strips 57 and 58 are adjusted in such a manner that a slight deflection of the wire belts takes place preferably on each strip. Due to the resilient supporting of the lower strips 57, the adjustment, once effected, is insensitive to changes in the quantity or quality of pulp, so that no backing up takes place in front of the strips and, nevertheless, an effective introduction of turbulence forces into the fiber suspension takes place. In contradistinction to FIGS. 1 to 3, there is the possibility of adjusting each one of the strips 57/58 individually with respect to position in height and inclination relative to the travel path of the wire. In this way, one can even better control the quality of the paper produced, with respect to both the formation and the nature of its surface (printability). Differing from FIG. 4, the upper strips 58 could be supported resiliently and the lower strips 57 stationary. Another alternative could consist therein that not only the upper strips 58 but also the lower strips 57 are fastened in vertically displaceable mounts (as shown on the vacuum chamber 51). In such case, the springs 54 might possibly be eliminated.

Another difference between FIGS. 1 and 4 resides in the fact that in FIG. 4 the twin-wire zone rises in the direction of travel of the wires upwards with an inclination of, on the average, about 20° with respect to the horizontal. In this way, it is possible to keep the entire height of the twin-wire former relatively slight. In the third section III of the twin-wire zone, a flat forming shoe 23' is provided rather than a curved one, differing from FIG. 1. The separation of the upper wire 12 from the lower wire and the fiber web formed can take place, as in FIG. 1, on one of the flat suction boxes 31. Instead of this, however, the upper wire 12 can also be conducted up to the wire suction roll 20. There, as shown, it can wrap around a small part (or, alternatively, a larger part) of the circumference of the wire suction roll and then be returned via the reversing roll 19.

In the embodiment shown in FIG. 5, the twin-wire zone, as a whole, extends substantially in horizontal direction. The individual elements are substantially the same as in the embodiment of FIG. 4. However, there is the difference that the drainage strips 57 and 58 lying in the second section II of the twin-wire zone are arranged along a downwardly curved path of the twin-wire zone. Accordingly, an upwardly curved forming shoe 16, 23 is provided in the first section I and in the third section III of the twin-wire zone. This embodiment is advisable, in particular, for the modernizing of existing Fourdrinier paper machines.

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The embodiments shown have the feature in common that, in the second section II of the twin-wire zone, there are present preferably n flexibly supported strips 27/57 and $n+1$ rigidly supported strips. However, it is also possible to make the number of flexibly supported strips equal to or greater by one than the number of rigidly supported strips. Instead of a rigidly supported strip, a feed or discharge edge of a drainage box can also be provided. The minimum number n of flexibly supported strips is two (see FIG. 4). However, three or four flexibly supported strips are preferred.

What is claimed is:

1. A twin-wire former for the production of a paper web from a fiber suspension, the twin wire former comprising:

first and second web forming wire belts, means for directing the wire belts to travel along a path together for forming a twin wire zone of the twin wire former, with the web between the wire belts as the wire belts travel along the path through the twin wire zone, neither wire belt defining a single wire predrainage zone;

each wire belt forming an endless loop;

the twin wire zone having a first section at the start of the path through the twin wire zone, means for supporting the belts for forming a wedge shaped entrance slot into the first section, a fiber suspension supplying headbox having an outlet placed and directed for delivering fiber suspension from the headbox to the wedge shaped entrance slot of the first section of the twin wire zone; a curved drainage element in the first section, the curved drainage element having an open surface to enable drainage of water from the fiber suspension and being curved along the path of the belts through the twin wire zone, the curved drainage element being engaged by one of the wire belts, for curving the path of the belts around the curved drainage element after the entrance of the suspension into the entrance slot;

the twin wire zone having a second section following the first section along the path of the belts through the twin wire zone; in the second section, a plurality of first drainage strips are positioned within the loop of the first wire belt and are for contacting the first wire belt; in the second section, a plurality of second drainage strips are positioned within the loop of the second wire belt and are for contacting the second wire belt; the first strips being shifted in position along the path of the wire belts with respect to the second strips so that the first and second strips are offset and in a non-opposing relationship; first support means for resiliently supporting the first drainage strips against the respective wire belt that strip contacts;

second support means supporting the second drainage strips rigidly against the second wire belt;

the first drainage strips being located within the same wire belt loop as the curved drainage element and the second drainage strips being located within the other wire belt loop; the first one of the second drainage strips being located upstream of the first one of the first drainage strips and the last one of the second drainage strips being located downstream of the last one of the first drainage strips;

means for supplying a vacuum in the area of the second drainage strips;

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the twin wire zone having a third section following the second section along the path of the wire belts through the twin wire zone; a stationary drainage element in the third section, for being engaged by one of the wire belts as the wire belts travel over the stationary drainage element, the stationary drainage element having an open surface to enable water to be drained through the wire belt in contact therewith; and the twin wire zone being free of rolls which deflect the twin wire zone.

2. The twin wire former of claim 1, wherein each of the drainage strips has a respective "thickness in the direction along the path through the twin wire zone; neighboring ones of the first drainage strips are spaced a minimum distance of about three times the respective first strip thickness, and neighboring ones of the second drainage strips are also spaced a minimum distance of about three times the respective second strip thickness.

3. The twin wire former of claim 1, wherein the support means for the second drainage strips include means enabling adjustment of the position of the second drainage strips relative to the second wire belt to set the initial rigid position thereof.

4. The twin wire former of claim 3, wherein the support means for the second drainage strips comprise a support body to which the second drainage strips are supported, and bearings on which the support body is supported for enabling displacement of the support body across the path of the wire belts through the second section.

5. The twin wire former of claim 1, wherein the first and second support means comprise a respective individual support body supporting each of at least one of the first and second drainage strips individually, and means supporting the respective support body for each strip to be displaceable for enabling displacement of the respective strip transverse to the direction of the path of the wire belts.

6. The twin wire former of claim 1, wherein the first and second support means comprise a respective individual support body supporting each of the first and second drainage strips individually and means further supporting the respective support body of at least one of the first and second strips for enabling said at least one strip to be moved transverse to the direction of the path of the wire belts.

7. The twin wire former of claim 1, further comprising a curved stationary forming shoe in the first section of the twin wire zone and following after and spaced from the curved drainage element along the path of the wire belts through the first section;

a first section strip disposed at the second wire belt and in the space between the curved drainage element and the curved stationary forming shoe in the first section of the twin wire zone along the path of the wire belts through the twin wire zone for enabling removal of water from the second wire belt.

8. The twin wire former of claim 1, wherein the stationary drainage element in the third section of the twin wire zone has a curvature that is curved in the same

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direction as the curvature of the curved drainage element in the first section of the twin wire zone.

9. The twin wire former of claim 8, further comprising an additional strip in the third section of the twin wire zone following the stationary drainage element and disposed against the other wire belt than the stationary drainage element.

10. The twin wire former of claim 8, wherein the curved drainage element in the first section of the twin wire zone and the stationary drainage element in the third section of the twin wire zone are arranged against the same one of the first and second wire belts.

11. The twin wire former of claim 1, further comprising a suction roll at one of the wire belts and located after the stationary drainage element along the path of the wire belts; both of the wire belts being wrapped about part of the circumference of the suction roll.

12. The twin wire former of claim 1, wherein the means for directing the wire belts are positioned so that the twin wire zone rises substantially vertically upwardly in the path of travel of the wire belts through the twin wire zone.

13. The twin wire former of claim 1, wherein the means for directing the wire belts are positioned so that the twin wire zone rises gradually upwardly along the path of travel of the wire belts through the twin wire zone at an incline with respect to the horizontal in the range of about 10° to 30°.

14. The twin wire former of claim 1, wherein the first and the second drainage strips in the second section of the twin wire zone are both arranged one after the other along the path of the wire belts through the twin wire zone so as to define a curvature for the path of the wire belts through the second section.

15. The twin wire former of claim 14, wherein the first and second drainage strips are positioned in the second section of the twin wire zone to define a curvature for the path of the wire belts through the second section of the twin wire zone that is opposite the curvature of the curved drainage element in the first section of the twin wire zone.

16. The twin wire former of claim 1, wherein the means for directing the wire belts are positioned so that the twin wire zone extends substantially horizontally;

the curved drainage element in the first section of the twin wire zone being generally curved upwardly for giving the path of the wire belts through the first section of the twin wire zone a generally upward curve; the first and second drainage strips in the second section of the twin wire zone being so positioned as to give the wire belts a generally downward curvature through at least part of the second section of the twin wire zone and the stationary drainage element in the third section of the twin wire zone is curved in a direction to give the wire belts passing through the third section of the twin wire zone a generally upward curvature.

17. The twin wire former of claim 1, wherein the stationary drainage element is curved.

18. The twin wire former of claim 1, wherein the stationary drainage element includes means for providing suction thereto to facilitate drainage of water.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 5,389,206
DATED : February 14, 1995
INVENTOR(S) : Rudolf Buck et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the title page in item [56] References Cited-U.S.
Patent Documents, change "3,994,744, 11/1976, Halme
et al." to --3,994,774, 11/1976, Halme et al.--

Signed and Sealed this
Second Day of April, 1996

Attest:



BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks

Exhibit 6

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

VOITH PAPER GMBH & CO. KG,)	
a Company organized and)	
existing under the laws of Germany,)	
)	
Plaintiff,)	
)	C.A. No. 07-0226-JJF
v.)	
)	
JOHNSONFOILS, INC.)	
a Delaware Corporation,)	
)	
Defendant.)	

PLAINTIFF'S FIRST SET OF INTERROGATORIES TO JOHNSONFOILS, INC.

Pursuant to Rule 33 of the Federal Rules of Civil Procedure, Plaintiff Voith Paper GmbH & Co. KG (hereinafter, "Plaintiff") requests that Defendant JohnsonFoilS, Inc. (hereinafter, "Defendant") answers the following interrogatories separately, fully, and under oath, within thirty (30) days of service. In accordance with Federal Rule of Civil Procedure 26(e), Defendant is subject to a duty to seasonably amend all responses to these interrogatories. The following definitions and instructions apply, as do the definitions set forth in Local Rule 26.5(c).

DEFINITIONS

These interrogatories shall be deemed to be continuing within the meaning of Fed. R. Civ. P. 26 (e) (1) and (2) with respect to any additional information which becomes known to Defendant or its counsel up to and including the time of trial. Answers hereto shall be enlarged, diminished, or otherwise modified to include any information required by Fed. R. Civ. P. 26 (e) (1) and (2) as acquired by Defendant subsequent to the date of its initial answers within a reasonable time after the acquisition of such information.

The singular shall include the plural and *vice versa*, and words in any gender shall include the other gender.

The term "Patents-in-suit" means the patent that are the subject of the above-captioned matter, specifically including U.S. Pat. Nos. 5,718,805 and 5,972,168 (collectively hereinafter "the Patents-in-suit").

The term "Prior Art" shall be construed in accordance with the meaning given that term in Title 35, United States Code, and interpretations thereof provided by the federal judiciary.

The term "Plaintiff" means Voith Paper GmbH & Co. KG

The term "Defendant" means JohnsonFoils, Inc.; any predecessor business organization of the Defendant, and any wholly or partly owned subsidiary, division, parent, joint venture, or other entity in which any or all of Defendant is a material participant or equity interest holder, or was a material participant or equity interest holder at any time.

The term "Person" means any individual or organization, including sole proprietorship, partnership, corporation, association, governmental body or agency, or other legal entity.

The term "Organization" means domestic or foreign, public or private corporations, partnerships or proprietorships, as well as all other business organizations, associations, forms, trustees, or legal entities.

The term "Document" means any medium, upon which information can be communicated, in the possession, custody or control of Defendant, its counsels or its consultants, or known to Defendant, its counsels or its consultants, and is used in a comprehensive sense to include, without limitation, the following items, whether printed, typed, written or produced by hand or stamp, recorded, microfilmed, photographed, video-

taped, filmed, stored on information storage means such as data bases, tapes, disks, hard drives, cassettes and/or other memory devices and computer records of any type, or any copy of Documents reproduced by any process, whether or not claimed to be privileged, confidential or personal: letters, notes, memoranda, reports, records, agreements, working papers, communications (including interdepartmental or intradepartmental communications, inter-company or intra-company communications), correspondence, summaries or records of personal conversations, diaries, e-mails, facsimile transmissions, forecasts, statistical statements, tables, graphs, laboratory reports, research reports, notebooks, books, charts, spreadsheets, plans, production files, blueprints, schematics, flow charts, computer programs, including source code and associated documentation both integral and separate from the program, engineering specifications, software specifications, diagrams, drawings, manuals, instructions and/or procedures, including, but not limited to, installation instructions or procedures, operating instructions or procedures, calibration instructions or procedures, maintenance or service instructions or procedures, photographs, minutes or records of meetings, minutes or records of conferences, expressions or statements of policy, lists of persons attending meetings or conferences, recorded statements, interviews or conversations, transcripts, reports or summaries of interviews, reports or summaries of investigations, opinions or reports or summaries of either negotiations or preparations for such, brochures, pamphlets, advertisements, circulars, press releases, price lists, instruments, accounts, bills of sale, purchase orders, quotations, terms of sale, invoices, lists of expenses, both fixed and variable, and all other materials on any tangible medium of expression, and all original and/or preliminary notes. Any comment or notation appearing on any Document, and not a part of the original text, is to be considered a separate "Document." Unless otherwise noted, the

Documents requested are those prepared or existing at the time that Defendant's Answer and Counterclaims were filed in the present action and those prepared since that time.

The terms "Identify" or "Identity," in the case of an individual, mean to state the person's full name; home address (present or last known); employer or business affiliation, business address and position; email address(es), and the relevant time period and nature of each of his present and prior employment positions or affiliations with Defendant.

The terms "Identify" or "Identity," in the case of an Organization, mean to state the organization's full name; type of organization (*i.e.*, corporation, partnership, etc.); the post office address of its principal place of business; date(s) and state(s) or country(ies) of incorporation; the identities of its principal officers and directors; and, any date of dissolution.

The terms "Identify" or "Identify," in the case of a Document, mean to state the Document's title and a description of its subject matter; the type or nature of the Document (*e.g.*, e-mail, letter, memorandum, telegram, chart, laboratory report, etc.); the identity of all person(s) who prepared the Document; the identity of all person(s) to whom copies were provided and/or submitted; the date the Document was prepared; its present location and custodian; and all other means of identifying it with sufficient particularity to satisfy the requirements for its inclusion in a demand or request for its production pursuant to Fed. R. Civ. P. 34.

The term "Identify" or "Identify," in the case of software, computer program, application, system, apparatus, device, component thereof, or other thing, means to describe the system or device, component or thing by name, model number, type, storage capacity, part number, and all other means of identifying it with sufficient particularity to satisfy the requirements for its inclusion in a demand or request for its production pursuant to Fed. R. Civ. P. 34.

In the event Defendant contends that any Document asked to be Identified is privileged or otherwise excludable from discovery, Defendant is requested to specify the basis for the privilege or other grounds for exclusion in addition to the Document Identification information requested above.

The term "Identify with Specificity," in addition to what is requested in the paragraphs above, means to Identify the responsive Documents by Bates number and to particularly point out the specific page(s), paragraph(s) and line(s) where the requested information can be found. In the case of a patent, in addition to the patent number, the specific column and line numbers should be provided.

The terms "Accused Product" and "Accused Products" as used herein means each and every paper forming machine which Defendant has modified, or contracted to modify, to utilize one or more resiliently supported blades.

The term "Client" as used herein means any and all Persons, and/or Organizations that is a client of Defendant in relation with the Accused Products.

The term "Customer" as used herein means any and all Persons, and/or Organizations that is a customer of Defendant in relation with the Accused Products.

INSTRUCTIONS

The form of the responses to this first set of interrogatories is to comply with Federal Rule 33(b) of the Federal Rules of Civil Procedure.

INTERROGATORIES

INTERROGATORY NO. 1:

Identify each and every paper forming machine which Defendant has modified, or contracted to modify, to utilize one or more resiliently supported blades.

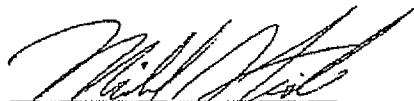
CERTIFICATE OF SERVICE

I hereby certify that a copy of the PLAINTIFF'S FIRST SET OF INTERROGATORIES TO JOHNSONFOILS, INC. was served on Attorneys for Defendant JohnsonFoils, Inc., via Electronic Mail and First Class Mail:

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Date: July 26, 2007



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Attorneys for Plaintiff Voith Paper GmbH & Co. KG

Exhibit 7

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

VOITH PAPER GMBH & CO. KG,)	
a Company organized and)	
existing under the laws of Germany,)	
)	
Plaintiff,)	
)	C.A. No. 07-0226-JJF
v.)	
)	
JOHNSONFOILS, INC.)	
a Delaware Corporation,)	
)	
Defendant.)	

**PLAINTIFF'S FIRST SET OF REQUESTS FOR PRODUCTION
TO JOHNSONFOILS, INC.**

Pursuant to Rule 34 of the Federal Rules of Civil Procedure, Plaintiff Voith Paper GmbH & Co. KG (hereinafter, "Plaintiff") requests that Defendant JohnsonFoils, Inc. (hereinafter, "Defendant") produces for inspection and copying all of the following documents and other tangible things that are in its possession, custody, or control. Production shall take place within thirty (30) days of this request, at the offices of Greenblum & Bernstein, P.L.C., 1950 Roland Clarke Place, Reston, Virginia 20191, or at such other location and time as the parties agree. In accordance with Federal Rule of Civil Procedure 26(e), Defendant is subject to a duty to seasonably amend all responses to these requests for production. The following definitions and instructions apply.

DEFINITIONS

Plaintiff incorporates by reference the Definitions contained in Plaintiff's First Set of Interrogatories served concurrently herewith.

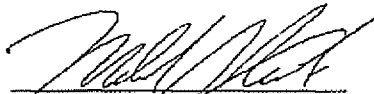
CERTIFICATE OF SERVICE

I hereby certify that a copy of the PLAINTIFF'S FIRST SET OF REQUESTS FOR PRODUCTION TO JOHNSONFOILS, INC. was served on Attorneys for Defendant JohnsonFoils, Inc., via Electronic Mail and First Class Mail:

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Date: July 26, 2007



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